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Original Research

Investigating the Status and Errors of Search Strategy in Persian Medical Systematic Reviews and Meta-Analyses

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Abstract

Search strategy is one of the main criteria for quality assessment of meta-analyses and systematic reviews. This descriptive-analytical research aims to investigate the status and errors of search strategy in Persian medical meta-analyses and systematic reviews indexed in The Scientific Information Database (SID) until February 2023. A total of 421 articles were identified. A checklist containing 31 items was used to collect the data. It is established based on a similar study and getting experts' opinions to check the status of search strategy reporting in articles and collaboration of librarians. Using SPSS version 25, descriptive statistics was used to analyze the data. The results showed that 15.9% of articles reported the systematic search strategy; 97.1% of the reviewed articles did not mention the collaboration of librarians in formulating the search strategies. 17.3% of articles had complete comprehensiveness regarding the number of databases used. The most common errors in PubMed and Scopus were "*Not using controlled keywords*," but in the Web of Science database, it was "*Not using all the concepts and keywords related to the subject*". The final result is that in most Persian medical meta-analyses and systematic reviews, the search strategy does not have a proper status in terms of reporting in the article and errors, which can influence the recall and reduce the quality of this type of article. Not having enough skills in how to search effectively and not using librarians in searching can be the cause of this situation.

Keywords: Systematic Review, Meta-Analysis, Search Strategy, Search Errors, Medicine, Persian Documents.

Introduction

"Meta-analyses" and "systematic reviews" have become very important regarding the ever-increasing amount of information faced by health service providers and policymakers. These studies are valuable research tools for evaluating the results of previous research, removing

biased inferences, and making more convincing conclusions related to research questions. As a result, it is possible to collect reliable evidence and develop evidence-based guidelines (Eskrootchi, Mohammadi, Panahi & Zahedi, 2020). A systematic review is a review of the latest scientific findings in a specific field whose purpose is to inform, evaluate, and interpret (Malboosbaf & Azizi, 2010). It is designed to answer a research question based on an unbiased assessment and integration of all relevant and high-quality studies and research evidence (Dalili Saleh & Ziaee, 2016). A meta-analysis is a quantitative, formal, and epidemiological study that systematically evaluates previous research results. Its purpose is to integrate and summarize many and sometimes contradictory findings of various research to easily understand and identify the homogeneous and heterogeneous results, determine the actual effect size, resolve the contradictions of the results, and generalize the results to the larger population (Dao & Ta, 2020; Koffel, 2015; Moher, Tetzlaff, Tricco, Sampson & Altman, 2007).

Systematic reviews and meta-analyses, especially in health and medicine sciences, are more critical regarding their role in clinical decisions. These studies are conducted on clinical trials (diagnosis, screening, and prognosis), public health interventions, adverse effects (harm), economic evaluation (cost), and how to intervene (Gopalakrishnan & Ganeshkumar, 2013). Due to a large amount of primary research on medicine and health and their possible contradictory results, it is difficult for policymakers and health professionals to collect, evaluate, and integrate these results due to lack of time or lack of sufficient skills. This challenge is solved to a large extent by conducting systematic reviews and meta-analyses (Dalili Saleh & Ziaee, 2016). They link the findings of studies and evidence-based and successful clinical decisions based on available scientific evidence and personal experiences (Haidich, 2010; Malboosbaf & Azizi, 2010). Because these studies include a wider variety of patient types in terms of age, sex, race/ethnicity, and nationality than any other study, external validity or generalizability of their findings and usefulness to clinicians practicing evidence-based medicine will increase (Martín-Rodero, Sanz-Valero, & Galindo-Villardón, 2018). Considering the importance and role of meta-analyses and systematic reviews in health and clinical decisions, these studies should be conducted and reported with great accuracy, and the methodology of these studies should be carefully examined to verify the accuracy and validity of their results. For this purpose, various guidelines (such as AMSTAR, QuoRom, and PRISMA) have been developed to provide a standard for evaluating the quality of this type of study. By using these guidelines, some studies (Ghafoori, Taheri, Mardi, Sarafraz & Negarandeh, 2015; Seo & Kim, 2012; Sequeira-Byron, Fedorowicz, Jagannath & Sharif, 2011) have been conducted on evaluating the quality of systematic reviews and meta-analyses, especially in the field of nursing and healthcare.

One of the criteria for evaluating the quality of meta-analyses and systematic reviews in all assessment guidelines is the comprehensiveness of included studies and the correctness of the database search strategy. Not reporting or reporting unsystematically the search strategy in the article makes it difficult to judge whether the search strategy is correct. Therefore, researchers should systematically provide an all-embracing report of their search strategy (a search strategy in which all key concepts in controlled and free Language, search fields, and their appropriate combination using Boolean operators are formulated). Because reporting the systematic search strategy can be considered a criterion for evaluating the report's quality, validity, and methodology in these studies.

The purpose of the search in meta-analyses and systematic reviews is to retrieve the maximum number of documents potentially related to the subject of the study to minimize the bias in the results (Puljak, 2017). Borrowing from information storage and retrieval systems, we expressed these features of search strategy under the title of *Recall* and *Precision.* Recall means that the search strategy is formulated in such a way that it can retrieve the most documents related to the subject, and *Precision* implies the ability to remove irrelevant documents. A proper search strategy for systematic reviews and meta-analyses should be comprehensive in terms of databases to be searched, and it should also be free of errors that distort the recall and precision of retrieved articles. To reach a proper search strategy, it is necessary to search several databases using an error-free comprehensive search strategy (ibid).

Some measures can be used in most databases to develop a search strategy to retrieve the most relevant documents. These measures are:

1. Use controlled vocabulary to increase the recall of retrieved documents)

2. Use Boolean operators, including AND (to increase the precision of retrieved documents), OR (to increase the recall of retrieved documents), NOT (to increase the precision of retrieved documents), *parentheses,* and *quotation* marks (to increase the precision of retrieved documents), and *Truncation/Wildcard* (to increase the recall of retrieved documents).

3. Use appropriate fields [tags] to search: Records in databases have different fields, each containing a piece of bibliographic information. Title, abstract, keyword, and controlled keywords (descriptors) are considered subject analysis fields (Osareh, 2018). Searching in these fields is essential to increase recall and precision in systematic reviews and meta-analyses.

On the other hand, an accurate and comprehensive search in systematic reviews and meta-analyses requires selecting appropriate and relevant keywords and proper databases and the specialized skill to formulate an effective search strategy (Eskrootchi et al., 2020). Since the 1990s, librarians, as professional groups, have been involved in information-seeking for systematic reviews. Since then, librarians have been recognized for their skills as searchers of the evidence needed to conduct systematic reviews. Librarians have been involved in some of the tasks of systematic reviews and meta-analyses, including search, selection of information resources, citation management, writing, and critical evaluation (Spencer & Eldredge, 2018).

The status of the search strategy has not been investigated so far in Persian medical systematic reviews and meta-analyses. Still, some studies have been done on search strategies in systematic reviews and meta-analyses in English. Considering the importance of search strategy in these studies, we intended to investigate the status and errors of the search strategy and collaboration of librarians in Persian medical systematic reviews and meta-analyses indexed in The Scientific Information Database (SID) (www.sid.ir). SID is a relatively comprehensive database with full-text articles that overlap entirely with the number of publications in the Information System of Iranian Medical Sciences Journals (https://irisweb.ir). For this purpose, the following questions will be answered:

1. What is the status of reporting search strategy in the systematic reviews and meta-analyses?

2. What is the collaboration status of librarians in conducting systematic reviews and meta-analyses?

3. What is the comprehensiveness of databases used in systematic reviews and meta-analyses?

4. What are the search strategy errors in systematic reviews and meta-analyses?

Literature Review

Several studies have been conducted on the topic of this research. Literature reviews on search strategy status in systematic reviews and meta-analyses indicate some errors and defects. Salvador-Oliván, Marco-Cuenca, and Arquero-Avilés (2019) examined 137 systematic reviews and found that in 92.7% of them, there are errors in the search strategy for MEDLINE/PubMed. Errors that influenced recall had the highest frequency (78.1%), and other errors, including "not using all concepts in both natural language and controlled language using Mesh," were observed and in their study of twenty-three systematic reviews, Aagaard, Lun,d, and Juhl (2016) emphasized searching more databases to identify all effect studies on musculoskeletal disorders, to increase the recall of retrieved documents. Abdulla and Krishnamurthy (2016) also recommended using several healthcare specialty databases and not limiting the results to only English publications. Sampson and McGowan (2006), by evaluating MEDLINE search strategies of 63 systematic reviews, identified errors in 82.5% of studies that could potentially lower recall of relevant studies. These errors included missed Mesh terms, irrelevant Mesh or accessible text terms, spelling variants, and Boolean operator errors.

Despite the skills and essential role of librarians in formulating an accurate and comprehensive search strategy, the results of some studies (Eskrootchi et al., 2020; Spencer & Eldredge, 2018; Townsend et al., 2017) indicate that librarians do not have an essential role in formulating the search strategy for systematic reviews and meta-analyses. Nevertheless, according to Rethlefsen, Farrell, Osterhaus Trzasko, and Brigham (2015), the participation of librarians can positively improve the quality of these studies.

The final result of the literature review indicated that many systematic reviews and meta-analyses have errors in the search strategies established (Table 1), and librarians have been used less in these studies.

Table 1
A summary of errors found in search strategies in previous studies

1. No truncation or truncation in inadequate places 2. Truncation syntax error 3. Missing Medical Subject Headings (MeSH) terms 4. No search for MeSH terms in the field [mesh] 5. Search for MeSH terms in the field 6. Searching for a MeSH phrase enclosed in double quotes.	7. Missing synonyms 8. Inappropriate use of Boolean operators 9. Missing parenthesis 10. Errors in searching for phrases 11. Combining the words of a phrase with AND

Materials and Methods

In this descriptive research, conducted with content analysis in 2023, all 421 systematic reviews and meta-analyses on medicine indexed in The Scientific Information Database (SID) (available in: www.sid.ir) until February 2023 were analyzed. To retrieve the articles, we searched the SID database using the keywords "systematic review," "Meta-analysis," and other related keywords in Persian separately (due to the impossibility of establishing a search strategy) and using the filter "Subject area" all articles were retrieved and entered into Endnote software. The inclusion criteria were systematic review and meta-analysis articles on medical science and the exclusion criteria were articles whose full text was unavailable. In the

preliminary search, 582 articles were found, and by removing 161 duplicate articles, the remaining 421 articles were included in the study, and none of these were excluded. Of 421 articles, 183 were systematic reviews, and 238 were meta-analyses. A checklist containing 31 items was used to collect the required data. This checklist includes items to check the status of search strategy reporting in articles and collaboration of librarians, as well as the types of possible errors in the search strategy. This checklist was established based on two prior studies (Salvador-Oliván et al., 2019; Sampson & McGowan, 2006), and it was finalized after studying the "User Guide" section of each database, specialized literature on information storage and retrieval and also our knowledge and experience. With the opinions of 7 experts in the information sciences field, the items' validity was checked and confirmed. Data was extracted after downloading the articles in full text, using content analysis. To answer questions 1 to 3 of the research, we have used descriptive statistics, such as frequency and percentage, for data presented in the text of the articles. To determine the comprehensiveness of databases, the following model, designed by experts, was used:

Complete comprehensiveness: using PubMed, Web of Science, Scopus, Google Scholar, and other Persian and international databases.

Relative comprehensiveness: Using up to three international databases: PubMed, Web of Science, and Scopus.

Lack of comprehensiveness: Only using databases other than PubMed, Web of Science, and Scopus.

Regarding search strategy errors, as mentioned earlier, for a search strategy in a database to lead to the retrieval of all related articles (*Recall* and *Precision*), measures have been made in the databases that inappropriate use of any of them can lead to the retrieval of unacceptable results. Therefore, according to the checklist, all possible errors and defects in the search strategy in systematic reviews and meta-analyses were extracted. These errors were divided into the following four general categories:

1. Not using all the concepts and keywords related to the article's subject in formulating the search strategy: To avoid wasting time, the search strategy should be established to have the necessary *Precision*. This means that, as much as possible, all articles retrieved are specific and related to the topic. For this, it is necessary to include all required keywords and variables in the search strategy.
2. Not using preferred or controlled keywords: Using controlled terms in the search strategy will cause the retrieval results to be recalled.
3. Do not use or make incorrect use of Boolean operators.
4. Not use or incorrect use of appropriate fields [tags] for searching (include: Not use of the field (tag) of [tiab] and just use the field (tag) of [all fields])

In this study, due to the defects of search engines in Persian databases in the same way as in English databases, only the errors of the search strategy established in the three databases PubMed, Web of Science, and Scopus were investigated. For this purpose, an appropriate search strategy was established for each article according to each database. Then, the search strategies reported in the reviewed articles were compared with those of the other articles. This action provided an initial view of the proper search strategy for that article and thus made it easier to identify errors in the search strategies.

Results

What is the status of reporting search strategy in the systematic reviews and meta-analyses?

Examining the methodology of the articles showed that in terms of reporting the search strategy, they are divided into three categories: (1) articles in which the search strategy was not reported at all. The number of these articles was 45 (10.7%); (2) articles that did not systematically report the search strategy; 73.4% of articles (309 articles) were in this category; and (3) articles that systematically report the search strategy. The number of these articles was 67 (15.9%) (Table 2). Also, the review of the articles showed that out of 67 articles, 31 articles in the PubMed database, eight articles in Scopus, and 10 articles in Web of Science had systematically reported the search strategy that in the following, the errors in them will be examined.

What is the collaboration status of librarians in conducting systematic reviews and meta-analyses?

Investigating the studied articles indicated that librarians only cooperated in 12 articles (2.9%), and out of these 12 articles, they collaborated as co-authors in eight articles. In the other four articles, their collaboration was mentioned only in the text, and 97.1% of articles (409 articles) did not show any cooperation of librarians in conducting meta-analyses and systematic reviews (Table 2).

What is the comprehensiveness of databases used in systematic review and meta-analysis studies?

The results of the methodology review showed that out of 376 systematic reviews and meta-analyses, 19.4% (73 articles) used PubMed, Web of Science, Scopus, Google Scholar, and Persian databases to retrieve documents (Figure 1).

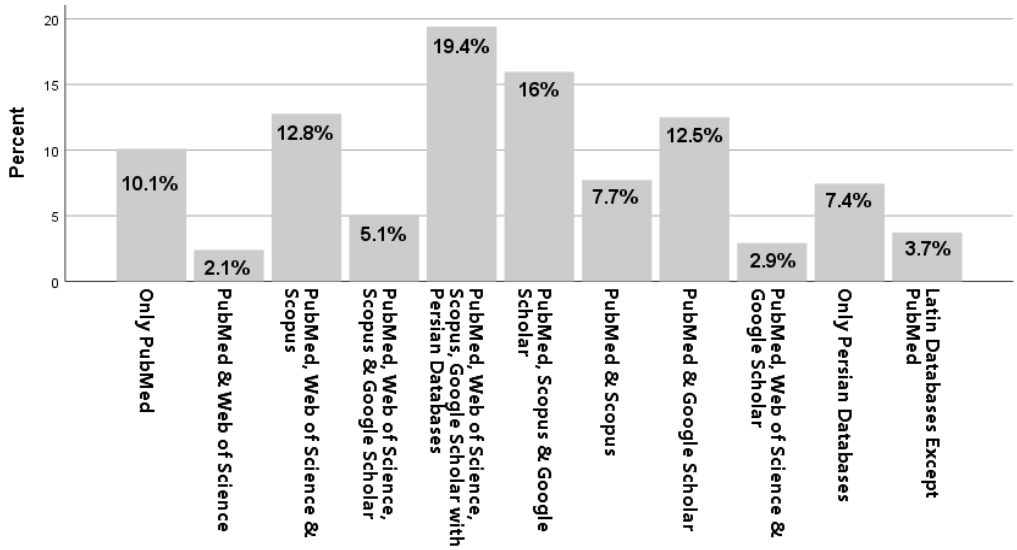

Figure 1: The amount of use and type of databases searched in systematic reviews and meta-analyses

According to the model designed, the degree of comprehensiveness in using databases by systematic reviews and meta-analyses is presented in Table 2. Out of 421 articles, 73 articles (17.3%) that used PubMed, Web of Science, Scopus, Google Scholar, and Persian databases to

retrieve documents had complete comprehensiveness, 275 articles (65.3%) had relative comprehensiveness, and 73 articles (17.3%) had lack of comprehensiveness in the use of databases.

Table 2
Status of reporting the search strategy, librarians' collaboration, and comprehensiveness of databases used in the reviews and meta-analyses

investigated characteristics of articles		Frequency (of 421 articles)	percent
Status of reporting the search strategy	Articles that reported unsystematic search strategy	309	73.4%
	Articles that reported systematic search strategy	67	15.9%
	Articles that did not report the search strategy	45	10.7%
Status of the participation of librarians in studies	Articles in which the librarian did not participate	401	97.1%
	Articles in which the librarian participates as an author	8	1.9%
	Articles in which the librarian does not participate as an author and their collaboration is mentioned only in the methodology	4	1%
comprehensiveness of databases used in studies	Articles with relative comprehensiveness in terms of the number of databases used	276	65.3%
	Articles with complete comprehensiveness in terms of the number of databases used	73	17.3%
	Articles lacking comprehensiveness in terms of the number of databases used	73	17.3%

What are the search strategy errors in systematic reviews and meta-analyses?

Because Persian databases do not support the systematic search strategy, this research investigated only the errors of the search strategy established in the three most important international databases: PubMed, Web of Science, and Scopus. As mentioned before, 67 articles systematically reported the search strategy, and 309 articles only mentioned search keywords in the text, so it was impossible to investigate their errors. So, the search errors in 67 articles were analyzed.

Errors in the search strategy formulated for the PubMed database

The review of the search strategy in the methodology of the articles showed that out of 67 articles, 31 used the PubMed database in their study. Only 10 articles (2.4% of 421 articles) were without errors, and 21 articles had errors, as presented in Table 3. The most errors (15 articles = 48.2% of 31) were related to "*Not using preferred keywords according to Mesh thesaurus*." After that, most of the errors were related to "*Not use of the field (tag) of [tiab]*" and "*Not use or incorrect use of Boolean operators*," respectively.

Table 3
the errors found in the search strategy of the reviewed articles in the PubMed database

Errors	Frequency	Percent (out of 31 articles)	Percent (out of 67 articles)	Percent (out of 421 articles)
Not using preferred or controlled keywords	15	48.2%	22.5%	3.4%
Not use of the field (tag) of [tiab]	10	32.2%	15%	2.4%
Not use or incorrect use of Boolean operators	7	22.7%	10.4%	1.7%
Not using all the concepts and keywords related to the subject of the article in formulating the search strategy	6	19.4%	9%	1.4%
Just use the field (tag) of [all fields]	2	6.4%	3%	0.4%
Without error	10	32.2%	15%	2.4%
Percentage of articles with errors or not reporting the search strategy (out of 421 articles)	411 articles (97.6%)			

Errors in the search strategy formulated for the Scopus database

The review of the search strategy in the methodology of the articles showed that out of 421 articles, eight used the Scopus database in their study, all of which had errors in the search strategy, as presented in Table 4. As can be seen in the table, the most errors (7 articles = 87.5%of 8) were related to "*Not use of the field (tag) of [INDEXTERMS] as controlled keywords.*" After that, most of the errors were related to "*Not using all the concepts and keywords related to the subject of the article in formulating the search strategy*" and "*Not use of the field (tag) of [TITLE-ABS-KEY],*" respectively.

Table 4
the errors found in the search strategy of the reviewed articles in the Scopus database

Errors	Frequency	Percent (out of 8 articles)	Percent (out of 421 articles)
Not use of the field (tag) of [INDEXTERMS] as controlled keywords	7	87.5%	1.6%
Not using all the concepts and keywords related to the subject of the article in formulating the search strategy	3	3.5%	0.6%
Not use of the field (tag) of [TITLE-ABS-KEY]	2	3%	0.4%
Not use or incorrect use of Boolean operators	1	12.5%	0.2%
Percentage of articles with errors or not reporting the search strategy (out of 421 articles)	413 articles (98.1%)		

Errors in the search strategy formulated for the Web of Science database

The review of the search strategy in the methodology of the articles showed that out of 421 articles, 10 used the Web of Science database in their study, seven articles (1.7% of 421 articles) were without errors, and three articles had errors, as presented in Table 5. As can be seen in the table, the most error (2 articles = 20%%of 10) was related to "*Not using all the concepts and keywords related to the subject*." "*Incorrect use of Boolean operators*" was another error in the search strategy of these articles.

Table 5

the errors found in the search strategy of the reviewed articles in the Web of Science database

Errors	Frequency	Percent (out of 10 articles)	Percent (out of 421 articles)
Without error	7	70%	1.7%
Not using all the concepts and keywords related to the subject of the article in formulating the search strategy	2	20%	0.4%
Not use or incorrect use of Boolean operators	1	12.5%	0.2%
Percentage of articles with errors or not reporting the search strategy (out of 421 articles)	411 articles (97.6%)		

Discussion

Evaluating the quality of systematic reviews and meta-analyses in medical sciences and healthcare is critical in gathering, evaluating, and integrating a large amount of different and sometimes contradictory research results to make clinical and medical decisions. One of the criteria for assessing the quality of these studies is the comprehensiveness of the documents retrieved from various databases, which is done through the formulation of a suitable search strategy that leads to the retrieval of all articles related to the subject (Recall and Precision). Not reporting or inappropriate search strategy formulation can challenge the quality and results of systematic reviews and meta-analyses. Librarians, especially medical librarians, due to their expertise in storing and retrieving information and formulating flawless search strategies, can help to increase the validity and quality of these studies. The results of some studies (Eskrootchi et al., 2020; Rethlefsen et al., 2015) indicate that the collaboration of librarians in systematic reviews and meta-analyses can have a positive effect on improving the quality of searching and thus increasing the quality of these studies. However, the results of our research, in line with the studies of Eskrootchi et al. (2020), Spencer & Eldredge (2018), and Townsend et al. (2017), showed that out of 421 meta-analyses and systematic reviews, 97.1% of the articles did not point out the collaboration of librarians. In only 12 articles, librarians have collaborated to establish the search strategy. In explaining this result, it can be said that, unfortunately, most of the authors and researchers may not be familiar with the profession of medical librarians and their expertise, and they must pay more attention to the involvement of librarians, especially medical librarians in accurate and comprehensive formulating and reporting of search strategy; Because the result of this research showed that among the articles that had no errors, librarians played a role in 4 articles.

One of the crucial features of systematic reviews and meta-analyses is that most studies related to the subject should be retrieved and included in the study. For this purpose, various databases, especially valid international databases such as PubMed, Web of Science, and Scopus, should be searched. The results showed that out of 421 articles, 73 articles (17.3%) that used PubMed, Web of Science, Scopus, Google Scholar, other databases, and Persian databases had complete comprehensiveness. Two hundred seventy-five articles (65.3%) and 73 (17.3%) had relative comprehensiveness and lacked comprehensiveness in databases, respectively. This means that most of the studied systematic reviews and meta-analyses are not comprehensive regarding the included studies. This result is aligned with the results of Aagaard et al. (2016) and Abdulla and Krishnamurthy (2016). They concluded that searching limited databases is insufficient to retrieve documents, and to achieve more comprehensiveness; it may be necessary to search various databases.

The result of the present study indicated that most articles did not report the search strategy, and those who presented a systematic report of the search strategy had errors in the formulated search strategy. The result showed that, unfortunately, 45 articles (10.7%) did not report the search strategy, 309 articles (73.4%) reported the unsystematic search strategy and only 67 articles (15.9%) reported the systematic search strategy, which indicates that neither the authors, nor the editors-in-chief of the journals, nor the reviewers paid attention to the report of the search strategy in the systematic review and meta-analysis articles as one of the quality criteria of these studies. Solving this problem requires that, like the author's guidelines for writing other types of articles, a guideline must be provided that requires the report of the search strategy in writing systematic review and meta-analysis articles. Also, when selecting referees, consider their experience writing meta-analysis articles. Also, choosing reviewers with expertise in writing systematic reviews and meta-analysis articles can help to solve this problem.

The results showed that in the search strategy of 31 articles that used the PubMed database for searching, only 10 (2.4% of 421 articles) were without errors, but in 21 articles, various errors were observed. This means that 97.6% of systematic review and meta-analysis articles had problems in terms of search strategy. One of the significant errors was "*Not using controlled keywords according to Mesh thesaurus*." Using preferred or controlled keywords according to thesauruses, performed in PubMed using the [mesh] field, will lead to more *Recall* and *Precision* of the retrieved documents. For example, in an article on "Effect of Stress Coping Skills Training on the Job Stress of Iranian Nurses," instead of using the controlled keyword "Occupational Stress," the keyword "Stress" is used without the tag of [mesh]. Another error that occurred was "*Not the use of the field (tag) of [tiab]*." Sometimes, in the article's subject, some concepts and keywords are essential in the search strategy to make the search more specific and increase its *precision*, especially in systematic reviews and meta-analyses. However, there is no entry for these concepts in thesauruses, and these concepts may not be used in indexing. Therefore, not using these concepts in the search strategy can be an error. For example, in an article on "Prevalence of depression in the elderly living in retirement homes in Iran," the word "retirement homes" should be included in the search strategy using the field [tiab] to increase the *precision* of the search; because the mentioned phrase does not find in the MeSH thesaurus. Another significant error was "*Not using or incorrectly using Boolean*

operators". These operators are used to increase *Recall* and *Precision*, and their incorrect use impairs retrieved results. For example, in one of the articles, the search strategy was reported as follows:

IGF-1 AND “Breast cancer”
IGF1 [ti] AND “Breast cancer”
IGF1 [ti] AND IGF binding protein-3 AND “Breast cancer” [ti]

As you can see, in this search strategy, controlled keywords and other words equivalent to “Breast cancer,” “IGF-1,” and “IGF binding protein-3” are not used at all using the OR operator, and the AND operator is not used correctly. Another error impairs the *Precision* of retrieval is "*Not using all the concepts and keywords related to the article's subject in formulating the search strategy*." For example, in an article on "The Role of Electronic Health during the Covid-19 Crisis", the term "Electronic Health" was not used in the search strategy, which can reduce the *precision* of the search.

In the search strategy, using the field or tag [all fields] is usually not recommended. This field noticeably reduces the precision of the search and increases the number of unrelated retrieved documents. This result is aligned with the result of Salvador-Oliván et al. (Salvador-Oliván et al., 2019). They found that errors that influenced the *recall* had the highest frequency, including “*not using all concepts in both natural language and controlled language using Mesh*.” The results of our study also confirmed that “*Not using controlled keywords according to MeSH thesaurus*” that leads to less *recall* is the most common error in search strategies used in the Pubmed database.

Out of 421 articles, 8 used the Scopus database in their study, all of which had errors in the search strategy. “*Not use of the field (tag) of [INDEXTERMS] as controlled keywords*” was the most error. This error influences the *recall* of the search. For example, in an article, the search strategy was reported as follows:

(TITLE-ABS-KEY ("Progressive Relaxation") AND TITLE-ABS-KEY
("Multiple Sclerosis"))

As seen, there are several errors: not using INDEXTERMS ("Progressive Muscle Relaxation") and not using the OR operator. Based on the EMTREE thesaurus, “Progressive Muscle Relaxation” is a controlled keyword. This error impairs the recall of the search.The results showed that out of 421 articles, 10 used the Web of Science database, seven were without errors, and three had errors. The most common error in these three search strategies was “*Not using all the concepts and keywords related to the article's subject in formulating the search strategy*.” For example, in an article on "Effect of Stress Coping Skills Training on the Job Stress of Iranian Nurses," the reported search strategy was as follows:

TOPIC: ("stress") AND TOPIC: ("nurse" OR "nursing") AND TOPIC: ("Iran")

The keywords "Job Stress" and "Stress Coping Skills Training" are not used in this strategy. This error reduces the *precision* of the search and increases the number of unrelated retrieved articles.

Since the principal errors of the search strategies in the three investigated databases were related to not using related and controlled keywords due to the professional design of the structure of all three databases in controlled indexing, the reason for these errors is the lack of familiarity and lack of sufficient skills of researchers in using the specialized thesauruses of the relevant databases, as well as not getting help from librarians in the process of formulating the search strategies. Therefore, it can be concluded that the participation of librarians in meta-analysis and systematic reviews can significantly help to increase the quality of the search strategy and, as a result, the quality of the studies.

Conclusion

Meta-analysis and systematic reviews of evidence-based clinical and medical decisions can be important. Therefore, it is essential to pay attention to the correct method of conducting these studies, including the proper formulation of search strategies for them. Despite this, the present study reveals that many Persian medical systematic reviews and meta-analyses did not report the method and approach of document search, and many errors occurred in the studies that reported the search strategy. The number of search strategies that include errors is very high, and most of these errors influence recall. Such errors were primarily related to missing controlled keywords according to related thesaurus that influence recall of search. Other frequent error types include failing to use all concepts and keywords related to the subject and synonyms to retrieve the various morphological variants of terms. These errors may be caused by the researchers' lack of familiarity with the structure of the storage and retrieval system in databases.

Implication for practice and research

This research has some limitations. Due to the weakness of Persian databases for searching, this study only examined the errors in the search strategy for three databases: PubMed, Scopus, and Web of Science. However, the present study's findings can provide a good understanding of the status and quality of the search strategy of Persian medical systematic reviews and meta-analyses, which are among the main criteria for quality assessment of meta-analyses and systematic reviews. An inappropriate search strategy can challenge the quality of systematic reviews and meta-analyses and cause the trust in their results to be distorted. The present study reveals that many errors have occurred in the Persian medical systematic reviews and meta-analyses, and the number of search strategies that include errors is very high. So, we recommend the following approaches to improve the quality of systematic review and meta-analysis studies:

1. Collaboration among librarians, especially medical librarians, can add to the richness and credibility of meta-analysis studies due to their skills and familiarity with the structure of thesauruses and the principles of indexing.
2. The editors-in-chief of the journals should be sensitive to the systemic reporting of the search strategy in the initial review of the systematic review and meta-analysis articles for their acceptance.

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Ethical Statement

The Ethics Committee of Hamadan University of Medical Sciences has ethically approved this study with code number IR.UMSHA.REC.1401.432

Declaration of Conflicting Interests

The authors declare no conflict of interest in this study.

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Appendix: The checklist

Checklist's items	Frequency	Percent
Articles in which the search strategy was not reported at all.		
Articles that reported the search strategy.		
Articles that did not systematically report the search strategy.		
Articles that systematically reported the search strategy.		
Articles that were only systematic reviews.		
Articles that were only Meta-analysis.		
Articles in which the librarian did not cooperate.		
Articles in which the librarian cooperated.		
Articles in which the librarian participates as an author.		
Articles where the librarian does not participate as an author and their collaboration is mentioned only in the methodology.		
Articles that used the PubMed database.		
Articles that used PubMed and Web of Science databases.		
Articles that used PubMed, Web of Science, and Scopus databases.		
Articles that used PubMed, Web of Science, Scopus, and Google Scholar databases.		
Articles that used PubMed, Web of Science, Scopus, and Google Scholar with Persian databases.		
Articles that used PubMed, Scopus, and Google Scholar databases.		
Articles that used PubMed and Scopus databases.		
Articles that used PubMed and Google Scholar databases.		
Articles that used PubMed, Web of Science, and Google Scholar databases.		
Articles that used other databases, except PubMed.		
Articles that used only Persian databases.		
Articles that used search engines.		
Articles that used gray literature.		
Articles with complete comprehensiveness in terms of the number of databases used.		
Articles with relative comprehensiveness in terms of the number of databases used.		
Articles lacking comprehensiveness in terms of the number of databases used.		
Articles that had errors in the PubMed database search strategy.		
Articles that did not have errors in the PubMed database search strategy.		

Checklist's items	Frequency	Percent
Articles that had errors in the Scopus database search strategy.		
Articles that had errors in the Web of Science database search strategy.		
Articles that did not have errors in the Web of Science database search strategy.		