Journal of Digital Health and Advanced Biomaterials
e-ISSN 3086-5972 Diamond Open Access journal.jdhab.org

TRACE-S: provenance and traceability of bibliographic searches in health research—methodological specification and exploratory documentary application

Robson Brandão[1]; Lígia Ferreira Gomes[2]

[1] School of Dentistry, University of São Paulo, São Paulo, Brazil.
[2] Department of Clinical and Toxicological Analyses, School of Pharmaceutical Sciences, University of São Paulo, São Paulo, Brazil.
Co-author ORCID: 0000-0002-9344-5820.

robsonb@usp.br • ORCID 0009-0005-1007-3283

4 November 2026 • pp. 5–12 • DOI 10.67463/hnah8p72

ABSTRACT

Objective: To specify Traceability in Scientific Search (TRACE-S) and examine its exploratory application to documenting the provenance of bibliographic searches. Methods: The specification was applied to three PubMed query versions concerning artificial intelligence and periapical lesions. V01 and V02 did not restrict search fields; V03 limited the search to title and abstract (Title/Abstract) and was repeated by the same agent. No date, language, species, or study-design filters were applied. Four executions were reconciled by PubMed identifier (PMID). The 20 lowest-numbered PMIDs were examined using artificial intelligence-assisted extraction followed by human verification. The internal integrity of the records was subsequently checked. Results: TRACE-S comprises six operational stages, seven documentary categories, and the Scientific Search Quality Checklist (SSQC-15), an unvalidated preliminary checklist. The four executions retrieved 123, 134, 127, and 127 records, corresponding to 134 unique PMIDs and 511 execution–document associations. Of the 20 records examined, seven were operationally included, eleven were excluded, and two remained unresolved; five inclusions relied on contextual inference. The audit confirmed the internal consistency of the retrieved sets, documentary links, and recorded history. Conclusion: The preserved dataset showed reconciliation and internal traceability across queries, executions, records, and eligibility judgments. The validity of the judgments, independent reconstruction, superiority over existing approaches, and validity of the SSQC-15 were not demonstrated.

KEYWORDS Information retrieval; Data provenance; Reproducibility; Bibliographic databases; Search strategy; Health informatics

EXPLORE Online article and supplementary materials

Article record

Canonical citation
Brandão R, Ferreira Gomes L. TRACE-S: provenance and traceability of bibliographic searches in health research—methodological specification and exploratory documentary application. J Digit Health Adv Biomater. 2026;1(2):5–12.
https://doi.org/10.67463/hnah8p72
Assessment Peer-reviewed

1 Introduction

The final expression of a search does not, by itself, show how concepts were translated into terms, why a query was modified, or which documents each execution retrieved. Evaluating this process requires preserving the relationships among information needs, search strategies, results, and eligibility decisions. Inadequate reporting of these relationships hinders critical appraisal and the reconstruction of published searches[1].

The Peer Review of Electronic Search Strategies (PRESS) provides guidance for the technical review of search strategies[2]; the PRISMA-S extension (Preferred Reporting Items for Systematic Reviews and Meta-Analyses literature search extension) sets out reporting requirements[3]; and Haddaway et al. describe a structure for documenting bibliographic search histories[4]. PROV-O (PROV Ontology), in turn, provides general concepts of entities, activities, and agents without prescribing the representation of queries and eligibility decisions[5]. These frameworks address different aspects of transparency. The question examined here is how, within a single task, concepts, terms, versions, executions, retrieved records, and judgments can be linked while preserving the sequence of decisions. The aim is neither to replace existing frameworks nor to treat documentary integrity as evidence of scientific validity.

TRACE-S (Traceability in Scientific Search) organizes this process through identifiable units and explicit relationships. Each query version, execution, document, and judgment retains its own identity; reasons for modifications, retrieval origins, and previous states remain accessible in the history. TRACE-S is neither a search algorithm nor a measure of information-retrieval performance. Canvas TRAMA may precede task delimitation, as it did in the educational project mentioned here, but its use is not part of the mandatory TRACE-S core[6].

The study had three objectives: to specify the documentary categories and relationships of TRACE-S, to illustrate its use across successive PubMed queries, and to verify the internal consistency of the preserved records. This final procedure was not prospective validation, independent re-execution, or a comparison of information-retrieval performance.

2 Foundations and intended use

The relevance of a record depends on its relationship to the research question and established criteria, not on the study's intrinsic methodological quality. Precision is the proportion of relevant records among those retrieved; estimating recall requires knowledge of the relevant-study set, defined independently of the strategy under examination[7]. Without such judgments and denominators, higher retrieval counts, stable responses, or greater overlap between sets do not establish better search performance.

Here, a query version is an identifiable executable expression accompanied by the reason for its modification. An execution is the event in which a version is applied to a source under documented conditions. The same expression may retrieve different sets as indexing, interfaces, or database coverage change[8,9]. Changes in operators, terms, fields, or filters generate new versions. When the research question or eligibility criteria change substantially, the specification calls for a new task linked to the previous one, thereby preserving historical judgments.

TRACE-S is intended for librarians, information professionals, and researchers who need to examine how a search was constructed, executed, and documented. Although conceptually independent of any specific application, this feature does not establish technical interoperability. The sufficiency of the rules across other tasks, third-party reconstruction, inter-rater agreement, and the associated workload remain to be investigated.

3 Methods

3.1 Study design and specification development

Development combined iterative conceptual modeling with an exploratory documentary application. Canvas TRAMA had previously been used to delimit an educational project concerning the standardization of search strategies. The later dental pilot had a different question and purpose; no documentation of a second completed workbook was found. The documents generated in this application belong to TRACE-S.

The specification drew on functions previously described in the literature for the technical review of queries, search reporting, preservation of search histories, and data provenance. Record categories, links, and rules for handling modifications and insufficient information were defined. The Scientific Search Quality Checklist (SSQC-15) was developed as a preliminary documentary inspection checklist, not as a scale of retrieval performance. No systematic development process, formal expert consensus, content validation, or reliability testing was undertaken. Accordingly, its items were not assigned weights, an aggregate score, or a cutoff.

3.2 Task, source, and eligibility

The exploratory task examined PubMed searches on the application of artificial intelligence to the radiographic identification of periapical lesions. PubMed was selected because bibliographic identifiers were available and responses from successive executions could be compared. The purpose was to demonstrate documentary relationships, not to conduct an exhaustive systematic review. Local identifiers PILOT-P01 (project), PILOT-S01 (scope), and PILOT-T01 (task) were used.

The queries used resources of the National Center for Biotechnology Information (NCBI), including PubMed and the E-utilities retrieval services[10–12]. No date, language, species, or study-design filters were applied. Search blocks comprised free-text terms without a mandatory Medical Subject Headings (MeSH) descriptor block. Radiographic modality and permanent dentition were assessed at eligibility screening rather than specified as retrieval-expression conditions. The strategy was appropriate for the intended documentary demonstration but does not support an inference of exhaustive coverage.

Eligibility criteria included original studies using dental radiographic images and artificial intelligence methods to detect, classify, or segment periapical lesions. Data on

permanent human dentition, or results reported separately for that population, were required, together with a quantitative comparison against a reference standard (ground truth). Studies lacking original empirical data, studies conducted exclusively in animals, and studies using incompatible imaging modalities were excluded. No minimum performance threshold was defined. The documentary protocol was preserved locally before the searches, without public preregistration.

3.3 Queries and preservation of provenance

Two thematic blocks were combined: periapical lesions and artificial intelligence. Alternatives within each block were connected by OR; the blocks were joined by AND. The first version (V01) used free-text terms without explicit field restrictions. V02 added 'deep learning' while retaining that configuration. In V03, the same terms were restricted to title and abstract (Title/Abstract). The immediate repetition of V03 by the same agent constituted the fourth execution but was not an independent reconstruction test.

V01 — initial query

("periapical lesion" OR "periapical lesions" OR "apical periodontitis")

AND ("artificial intelligence" OR "machine learning")

V02 — terminology expansion

("periapical lesion" OR "periapical lesions" OR "apical periodontitis")

AND ("artificial intelligence" OR "machine learning" OR "deep learning")

V03 — field restriction

("periapical lesion"[Title/Abstract] OR "periapical lesions"[Title/Abstract] OR "apical periodontitis"[Title/Abstract])

AND ("artificial intelligence"[Title/Abstract] OR "machine learning"[Title/Abstract] OR "deep learning"[Title/Abstract])

The documentary package retained the entered expressions, PubMed's effective translations, the parameters, and the PMID lists. During the subsequent audit, the four responses were compared with the Execution–Document relationships and the 134 bibliographic records preserved in Extensible Markup Language (XML), obtained through EFetch. Verification of the links showed internal consistency. This verification neither externally authenticates the recorded capture times nor independently reproduces the database responses.

3.4 Judgments and documentary analysis

The four executions were reconciled by PubMed identifier (PMID), preserving each document's retrieval origin. To illustrate the decision history, the 20 numerically lowest PMIDs in the union of the four retrieved sets were selected. This deterministic selection was not random and is not representative of the 134 retrieved records. Artificial intelligence (AI) assisted the initial extraction of data and evidence; the authors subsequently performed a human review. Eligibility states, evidence, rationales, and changes were recorded. There was no independent dual assessment, blinded adjudication, or systematic measurement of working time.

The analysis distinguished explicit textual confirmation from contextual inference concerning the population, clinical setting, and images. No uniform evidentiary threshold for accepting inferences was established in advance; therefore, operational inclusion does not mean that every criterion was explicitly confirmed in the text. Insufficient information was recorded as an unresolved judgment. Counts, intersections, between-set differences, and Jaccard indices were calculated. The subsequent audit examined relationships and events without generating new eligibility judgments.

4 TRACE-S documentary specification

4.1 Categories and relationships

The specification comprises seven categories: Task (question and criteria), Concept (information need), Term (expression and function), Query version (executable expression and rationale), Execution (application of a version under recorded conditions), Document (retrieved bibliographic record), and Judgment (decision, evidence, and history). Figure 1 presents the sequence of relationships; Table 1 lists the minimum elements. These categories are not formally equivalent to the classes of PROV-O.

The Version–Term relationship records the composition of expressions. Execution–Document preserves each retrieval occurrence, including when a document appears in different executions. A Judgment remains associated with the task and preserves previous states after revision. In the pilot, the files made it possible to check PMIDs and their links. Cardinalities, integrity constraints, and interoperability mappings required for external implementations were not fully formalized.

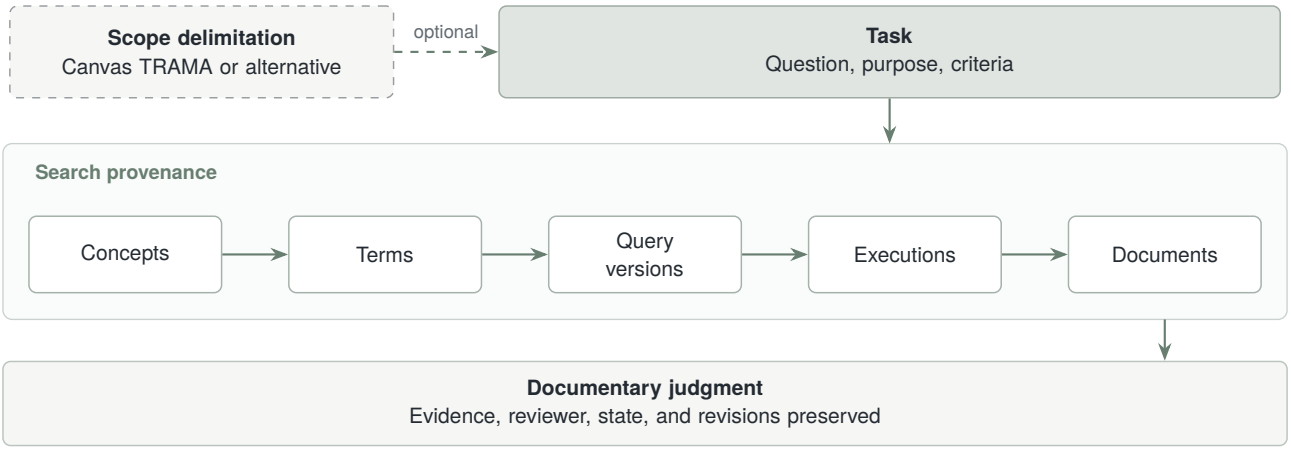
Scope delimitation may be linked to Canvas TRAMA by referring to a preserved workbook version. This link is optional and does not automatically import workbook fields into TRACE-S. Conceptual exclusion also does not require use of the NOT operator. Substantial changes to the research question or eligibility criteria should give rise to a new task related to the previous one, without replacing historical judgments.

4.2 Operational stages and SSQC-15

The workflow was divided into six revisable stages: (1) delimit the task, question, and eligibility criteria; (2) justify sources and export options; (3) document concepts and terms; (4) construct queries, including fields, filters, and operators; (5) review and version expressions, recording reasons for changes; and (6) execute searches, preserve results, and document judgments. The stages describe activities; the seven categories define what remains recorded.

The SSQC-15 contains fifteen documentary inspection questions (Table 2). Each item allows the responses 'yes', 'partial', 'no', and 'not applicable', accompanied by evidence and rationale. Some items concern the presence of records, whereas others require assessment of conceptual fidelity or the conditions for re-execution. Because the items do not measure a homogeneous construct and

Figure 1 — Proposed conceptual sequence for recording provenance in TRACE-S.



Source: prepared by the authors
Note: When used, Canvas TRAMA is an optional antecedent to scope delimitation. The arrows indicate proposed documentary relationships; they do not demonstrate causality, empirical validation, independent re-execution, or interoperability conformance.

Table 1. TRACE-S categories, minimum information, and documentary relationships.

Record	Minimum content	Relationship
Task	Question, purpose, fixed eligibility criteria; optional reference to preserved scope	Contains task-specific concepts and judgments
Concept	Definition and function	Belongs to the task; represented by terms
Term	Literal expression, source, language, and rationale	Linked to concept and query versions
Query version	Executable expression, platform, predecessor, rationale	Belongs to the task; may have multiple executions
Execution	Version, source, parameters, date and time, status, counts	Links the version to every returned document
Document	PMID, Digital Object Identifier (DOI), or reconciled bibliographic identity	Preserves all retrieval origins
Judgment	Task, document, evidence, reviewer, state, rationale	Preserves previous states and revisions

Source: prepared by the authors

have not been validated, their results do not support an aggregate score or cutoff.

4.3 Set comparisons and failure conditions

To examine changes between queries, each response was represented as a set of PMIDs. Let A denote the preceding execution and B the subsequent one. The intersection A ∩ B contains records present in both; B \ A identifies newly added records, and A \ B those no longer present. The union A ∪ B counts each PMID once, even if it was retrieved in more than one execution. Reconciliation therefore separates bibliographic identity from retrieval occurrence.

In the transition from V01 to V02, all 123 PMIDs were retained and eleven were added, yielding 134. Restricting the fields in V03 retained 127 records and no longer retrieved seven. These values describe differences between responses; they do not show that adding terms or restricting fields made the strategy more appropriate for the clinical question.

The Jaccard index was calculated as $J = |A \cap B| / |A \cup B|$, the proportion of shared identifiers relative to the union of the two sets. Its value ranges from zero to one and is undefined when both sets are empty. The observed indices were 0.9179 between V01 and V02, 0.9478 between V02 and V03, and 1.0000 when comparing E03 with E04. Overlap, however, is not equivalent to precision, recall, or relevance of the retrieved documents.

The records were checked against identifiers, documentary relationships, and cryptographic digests produced by the 256-bit Secure Hash Algorithm (SHA-256). Agreement between the digests and the manifest supports the internal integrity of the files examined. It does not certify the external origin of the results, the correctness of judgments, or the feasibility of reconstruction by third parties.

Three distinct situations were preserved: an execution completed with no records; an attempt interrupted by a technical error; and a retrieved document with unresolved eligibility. The first two concern execution; the last concerns judgment. Before E01, a failed attempt resulting from a domain-resolution error was recorded as an error and was not included in valid result counts.

Eligibility decisions were classified as relevant (R), irrelevant (I), or unresolved (U), such that $N = R + I + U$. When $U > 0$, the ratios R/N and $(R + U)/N$ establish

conditional bounds, assuming the remaining judgments are correct. Among the 20 records examined, these bounds are 7/20 (35%) and 9/20 (45%). They are neither confidence intervals nor estimates of precision for the 134 retrieved records. It should be noted that five of the seven inclusions relied on contextual inference.

5 Results of the documentary application

The four valid ESearch responses contained 123, 134, 127, and 127 PMIDs. The attempt preceding E01, interrupted by a domain-resolution error, was not counted. Together, the executions yielded 511 Execution–Document associations and 134 distinct records (Table 3). E04 returned a JavaScript Object Notation (JSON) response identical to E03, although it represented a separate event recorded by the same agent. No external certification of capture times is available.

Concepts C01 (periapical lesions) and C02 (artificial intelligence) formed the two mandatory search blocks. C03, concerning dental radiography and permanent dentition, was used in the eligibility assessment. The files conceitos.csv and protocolo_congelado.json preserve this distinction. C03 was therefore not an omitted retrieval block.

Six terms and 17 Version–Term links were verified: five in V01, six in V02, and six in V03. The 134 bibliographic records matched the preserved EFetch XML. These correspondences make it possible to identify the expressions used and the origin of each retrieval. They do not demonstrate terminological exhaustiveness, the clinical relevance of every record, or comparative performance.

Of the 20 PMIDs examined, seven studies were operationally included, eleven were judged ineligible, and two remained unresolved (Table 4). Explicit textual confirmation of permanent dentition was reported for the studies by Moidu et al. and Kirnbauer et al.[13,14]. Studies by Setzer et al., Ezhov et al., Zadrożny et al., Calazans et al., and Ari et al. were included on the basis of contextual inference[15–19]; for records by Orhan et al. and Bayrakdar et al., the available documentation did not sufficiently confirm dentition in the study samples or separately reported results for permanent teeth[20,21]. The other 114 records in the union were not assessed.

The study by Moidu et al. (PMID 34213664) illustrates the preservation of a revised decision. Following an initially inconclusive judgment, textual information concerning mature permanent mandibular teeth was recorded[13]. The history retains both states and the basis for the change; the documentary check was not an adjudication by an independent examiner.

In the subsequent verification, SHA-256 digests matched the 30 primary items in the original manifest. The 511 associations, the four execution lists, the 134 PMIDs, and the 20 current states were also confirmed as compatible with a history of 76 judgment events. An informational file mentioned in the external manifest was absent, but no discrepancy was identified among the 30 verified primary hashes. Because not all PDFs and original forms used for eligibility decisions were available, this check does not substantively validate the classifications.

6 Proposed independent evaluation

The first step in an independent evaluation will be to determine whether the categories and links suffice to reconstruct a task's history. The SSQC-15 also requires content-validity assessment, particularly for overlaps between source justification and identification (items 2 and 9), search limits and execution conditions (8 and 10), terminological links and conceptual fidelity (4 and 13), and result reconciliation and judgment denominators (11 and 14). For item 12, the presence of potentially re-executable records must be distinguished from an actual re-execution.

Subsequent studies may test the reconstruction of queries, retrieval links, and rationales for changes across different databases and tasks. Examiners should be unaware of historical judgments. Outcomes to be specified in advance include the proportion of correctly reconstructed links, inter-rater agreement, time required, and interpretation errors. Retrieval performance, in turn, will depend on a reference set of relevant studies established independently. None of these tests was conducted in the pilot.

Estimating the incremental contribution of TRACE-S will require comparison with existing structured practices, rather than merely with the absence of documentation. The cost of maintaining records must also be measured. Any integration with Canvas TRAMA is a separate question requiring its own evaluation.

7 Discussion

In the pilot, 134 distinct bibliographic identifiers were retrieved across four executions, producing 511 Execution–Document relationships. The difference between these totals is substantive: a PMID identifies the bibliographic record, whereas each association preserves the event in which that record appeared. Judgments add a decision-related dimension by documenting the basis for classification and, where a decision was revised, its previous state. Reconciliation demonstrated consistency within the package but did not independently verify the correctness of the decisions.

Existing approaches make complementary contributions. PRESS guides technical review of search strategies[2]; PRISMA-S provides reporting recommendations[3]; Haddaway et al. propose a structure for preserving search histories[4]; and Lin et al. recommend retaining source-specific exports, selection decisions, and information on the use of artificial intelligence[22]. The concern with traceability therefore predates TRACE-S. Its proposed distinctive feature is the joint description of Concept–Term, Term–Version, Version–Execution, Execution–Document, and Task–Judgment links, with rationales and previous versions retained. This study did not formally compare that architecture with existing models in terms of completeness, cost, or reconstructability.

Adding 'deep learning' yielded eleven additional PMIDs; limiting the search to title and abstract fields resulted in seven records no longer being retrieved. These shifts can be interpreted because the versions and their responses were preserved. Nevertheless, the use of a single database, a deliberately restricted terminological

Table 2. SSQC-15: preliminary documentary inspection items (unvalidated instrument).

No.	Inspection item	Evidence
1	Stable task	Identifier and consistent criteria
2	Justified sources	Database and platform rationale
3	Controlled vocabulary	Choice or rationale for not using it
4	Concept–term links	Origin and function of terms
5	Terminological variants	Synonyms, spelling variants, language
6	Logical operators	Grouping and Boolean logic
7	Platform syntax	Effective translations and query execution
8	Justified limits	Fields, dates, language, study design
9	Source identification	Database and platform
10	Execution conditions	Time zone, parameters, version
11	Reconciled counts	Exports and deduplication
12	Re-executable record	Independent reconstruction or outstanding issue
13	Conceptual fidelity	Alignment of question, concept, and term
14	Judgments and denominators	Relevant, irrelevant, unresolved, and origins
15	Version history	Predecessors, rationales, and outputs

Source: prepared by the authors

Table 3. Records retrieved per execution and changes relative to the preceding execution.

Execution	Version	PMIDs	Retained	Added	Lost	Jaccard
E01	V01	123	—	—	—	—
E02	V02	134	123	11	0	0.9179
E03	V03	127	127	0	7	0.9478
E04	V03 (repeat)	127	127	0	0	1.0000

Source: prepared by the authors
Note: Retained, added, and lost records are calculated relative to the immediately preceding execution. E04 is a repetition of V03 by the same agent, not an independent reconstruction.

expression, and the absence of an independently defined relevant-record set preclude calculation of recall. Since only 20 of 134 records were examined, the observed proportions cannot be used to estimate overall search precision. Nor does the deterministic selection support statistical inference to the entire retrieved set.

Preserving the unresolved state prevented insufficient information from being treated as definitive exclusion. Of the seven operational inclusions, five relied on contextual inference and two had reported textual confirmation of permanent dentition. The history of 76 events records changes and rationales. However, some full texts and original screening forms were not included in the audited package; what was confirmed was the consistency of the decision records, not their substantive correctness.

The fifteen SSQC-15 items cover different activities: some verify that documents are present, whereas others require judgments about conceptual adequacy or re-execution feasibility. This heterogeneity currently prevents treating the checklist as a unidimensional quality scale. Record sufficiency for attempting to reproduce a query and the success of an independent reconstruction must be assessed separately. Content validation and inter-rater agreement testing are future steps.

Four limitations qualify interpretation of the findings: neither the capture times nor the responses were externally authenticated; some full texts and original screening forms were absent from the audited package; no independent reconstruction or incremental comparison was performed; and eligibility was illustrated using a deterministic subset of 20 records. Documentary traceability is the demonstrated result. Retrieval quality and the validity of judgments require additional evidence.

8 Conclusion

The TRACE-S specification establishes documentary links among tasks, concepts, terms, query versions, executions, documents, and revisable judgments. In its exploratory PubMed application, the preserved files allowed reconciliation of 134 unique PMIDs, 511 Execution–Document relationships, 17 Version–Term links, and the documented history of eligibility judgments for 20 examined records. The task demonstrated the organization and internal consistency of these records, thereby meeting the study's descriptive objectives. The substantive validity of the judgments, independent reconstructability, superiority over existing systems, overall retrieval quality, and validity of the SSQC-15 were not evaluated.

Table 4. Eligibility judgments for the 20 records examined.

Decision	Sample positions	n	Evidence status
Operationally included	3, 8, 9, 11, 15, 18, 20	7	2 with explicit evidence; 5 contextual
Criterion not met	1, 4, 5, 6, 7, 10, 13, 14, 16, 17, 19	11	I
Unresolved at closure	2, 12	2	U: unresolved; irrelevance not established

Source: prepared by the authors
Note: Positions refer to the numerical ordering of PMIDs in the sample, not to the identifiers themselves. The other 114 records were not examined.

Table 5. Provenance files corresponding to the application results.

Result	Files in the archive
Expressions and translations	dados/versoes.csv; fontes/PILOT-E01.json–PILOT-E04.json
Execution conditions	execucoes.json; protocolo_congelado.json
Distinct PMIDs and associations	dados/documentos.csv; dados/execucao_documento.csv
Eligibility history	dados/revisao_humana_atual.csv; dados/revisao_humana.csv

Source: prepared by the authors
Note: The paths shown are relative to the 02_REGISTROS_PRESERVADOS/ folder in the confidential package. Verification of these files does not authorize public disclosure or automatic transmission of identified documentation to reviewers.

Supplementary materials and documentary availability

The package made available for confidential editorial inspection contains query expressions, ESearch/EFetch responses, documentary relationships, and judgment history. The audit identified an issue involving the external manifest and the absence of some full texts and original selection documents. Supplement 1 describes the optional Canvas TRAMA–TRACE-S interface; Supplement 2 describes eligibility judgments. Transmission of the identified package to reviewers or its public release requires authorization from the responsible custodians.

Use of artificial intelligence and scientific responsibility

The authors used Codex/OpenAI to support the formulation and execution of bibliographic queries, record processing, preliminary information extraction, and documentary and textual organization. Both authors reviewed and approved the pilot protocol and its incorporation into the manuscript. Extracted information, eligibility decisions, references, and AI-assisted content were reviewed and checked by the authors, who assume full responsibility for the submitted version. Canvas TRAMA was used to support research-scope delimitation and alignment of the question, objectives, and methods. The authors' review does not constitute an independent assessment or formal validation of TRACE-S or SSQC-15. AI is not an author. The study used published bibliographic records, without participant recruitment or processing of identifiable clinical records. Specific tool versions were not recorded in the authors' declaration.

Funding

This research received no funding.

Competing interests

The authors declare no competing interests.

Author contributions

Robson Brandão: research, manuscript writing, and preparation of supplementary materials. Lígia Ferreira Gomes: human verification and methodological checking. Both authors approved the manuscript, the supplementary materials, and the stated contributions. Human verification does not constitute independent scientific validation of TRACE-S or SSQC-15.

References

1. Rethlefsen ML, Brigham TJ, Price C, Moher D, Bouter LM, Kirkham JJ, et al. Systematic review search strategies are poorly reported and not reproducible: a cross-sectional metaresearch study. J Clin Epidemiol. 2024;166:111229. doi:10.1016/j.jclinepi.2023.111229.
2. McGowan J, Sampson M, Salzwedel DM, Cogo E, Foerster V, Lefebvre C. PRESS Peer Review of Electronic Search Strategies: 2015 guideline statement. J Clin Epidemiol. 2016;75:40–6. doi:10.1016/j.jclinepi.2016.01.021.
3. Rethlefsen ML, Kirtley S, Waffenschmidt S, Ayala AP, Moher D, Page MJ, et al. PRISMA-S: an extension to the PRISMA statement for reporting literature searches in systematic reviews. Syst Rev. 2021;10:39. doi:10.1186/s13643-020-01542-z.
4. Haddaway NR, Rethlefsen ML, Davies M, Glanville J, McGowan B, Nyhan K, et al. A suggested data structure for transparent and repeatable reporting of bibliographic searching. Campbell Syst Rev. 2022;18(4):e1288. doi:10.1002/cl2.1288.
5. Lebo T, Sahoo S, McGuinness D, editors. PROV-O: the PROV ontology [Internet]. W3C Recommendation. 2013

Apr 30 [cited 2026 Oct 28]. Available from: https://www.w3.org/TR/prov-o/.

6. Gonçalves L. Canvas TRAMA para delimitação do escopo da pesquisa: workbook metodológico em sete etapas. Version 2.0.5. Maringá: Scientexa Editora; 2026.
7. Lefebvre C, Glanville J, Briscoe S, Featherstone R, Littlewood A, Metzendorf MI, et al. Searching for and selecting studies. In: Higgins JPT, Thomas J, Chandler J, Cumpston M, Li T, Page MJ, et al., editors. Cochrane handbook for systematic reviews of interventions [Internet]. Version 6.5.1. Cochrane; 2025 [cited 2026 Oct 28]. Chapter 4. Available from: https://www.cochrane.org/authors/handbooks-and-manuals/handbook/current/chapter-04.
8. MacFarlane A, Russell-Rose T, Shokraneh F. Search strategy formulation for systematic reviews: issues, challenges and opportunities. Intell Syst Appl. 2022;15:200091. doi:10.1016/j.iswa.2022.200091.
9. Briscoe S. Errors to avoid when searching for studies for systematic reviews: a guide for nurse researchers. Int J Older People Nurs. 2023;18(3):e12533. doi:10.1111/opn.12533.
10. National Library of Medicine (US). PubMed user guide: search details, phrase searching and automatic term mapping [Internet]. Bethesda (MD): National Library of Medicine; [updated 2026 Sep 30; cited 2026 Oct 28]. Available from: https://pubmed.ncbi.nlm.nih.gov/help/.
11. National Library of Medicine (US). The 9 E-utilities and associated parameters. In: The insider's guide to accessing NLM data [Internet]. Bethesda (MD): National Library of Medicine; [cited 2026 Oct 28]. Available from: https://dataguide.nlm.nih.gov/eutilities/utilities.html.
12. National Center for Biotechnology Information (US). The E-utilities in-depth: parameters, syntax and more. In: Entrez programming utilities help [Internet]. Bethesda (MD): National Library of Medicine; [cited 2026 Oct 28]. Available from: https://www.ncbi.nlm.nih.gov/books/NBK25499/.
13. Moidu NP, Sharma S, Chawla A, Kumar V, Logani A. Deep learning for categorization of endodontic lesion based on radiographic periapical index scoring system. Clin Oral Investig. 2022;26(1):651–8. doi:10.1007/s00784-021-04043-y.
14. Kirnbauer B, Hadzic A, Jakse N, Bischof H, Stern D. Automatic detection of periapical osteolytic lesions on cone-beam computed tomography using deep convolutional neuronal networks. J Endod. 2022;48(11):1434–40. doi:10.1016/j.joen.2022.07.013.
15. Setzer FC, Shi KJ, Zhang Z, Yan H, Yoon H, Mupparapu M, et al. Artificial intelligence for the computer-aided detection of periapical lesions in cone-beam computed tomographic images. J Endod. 2020;46(7):987–93. doi:10.1016/j.joen.2020.03.025.
16. Ezhov M, Gusarev M, Golitsyna M, Yates JM, Kushnerev E, Tamimi D, et al. Clinically applicable artificial intelligence system for dental diagnosis with CBCT. Sci Rep. 2021;11(1):15006. doi:10.1038/s41598-021-94093-9.
17. Zadrożny Ł, Regulski P, Brus-Sawczuk K, Czajkowska M, Parkanyi L, Ganz S, et al. Artificial intelligence application in assessment of panoramic radiographs. Diagnostics (Basel). 2022;12(1):224. doi:10.3390/diagnostics12010224.
18. Calazans MAA, Ferreira FABS, Alcoforado MLMG, Santos AD, Pontual ADA, Madeiro F. Automatic classification system for periapical lesions in cone-beam computed tomography. Sensors (Basel). 2022;22(17):6481. doi:10.3390/s22176481.
19. Ari T, Sağlam H, Öksüzoğlu H, Kazan O, Bayrakdar İŞ, Duman SB, et al. Automatic feature segmentation in dental periapical radiographs. Diagnostics (Basel). 2022;12(12):3081. doi:10.3390/diagnostics12123081.
20. Orhan K, Bayrakdar IS, Ezhov M, Kravtsov A, Özyürek T. Evaluation of artificial intelligence for detecting periapical pathosis on cone-beam computed tomography scans. Int Endod J. 2020;53(5):680–9. doi:10.1111/iej.13265.
21. Bayrakdar IS, Orhan K, Çelik Ö, Bilgir E, Sağlam H, Kaplan FA, et al. A U-Net approach to apical lesion segmentation on panoramic radiographs. Biomed Res Int. 2022;2022:7035367. doi:10.1155/2022/7035367.
22. Lin L, Xing X, Wu C, Chen Y, Tong J, McClelland DJ, et al. Reproducible study identification and selection in systematic reviews: barriers and paths forward. BMJ Open. 2026;16(9):e123460. doi:10.1136/bmjopen-2026-123460.

License and reuse

CC BY 4.0

© 2026 Robson Brandão and Lígia Ferreira Gomes. This work is licensed under a Creative Commons Attribution 4.0 International License (CC BY 4.0).
https://creativecommons.org/licenses/by/4.0/

Publisher notice on AI, text and data mining

This article is made available under the Creative Commons Attribution 4.0 International License (CC BY 4.0). Reuse, including automated text and data mining, is permitted under the terms of the license, provided that appropriate credit is given, a link to the license is supplied, and any changes are indicated.