

Review Article

Literature search strategies in dental education and research

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الملخص

إن البحث المنظم هو مطلب أساسي لتعليم طب الأسنان القائم على البحث. لا يكون تنفيذ البحث مفيداً إلى أقصى حد له حتى يكون لدى الباحثين معرفة أساسية في البحث في الأدبيات العلمية. في هذه المقالة، قدمنا جميع الاستراتيجيات الأساسية وناقشنا بشكل أساسي البحث في طب الأسنان خطوة بخطوة مثل عامل التشغيل اليومي والاستخدام الصحيح للكلمات المفتاحية واختيار قواعد البيانات وتقييم نتائج البيانات وقبولها. وبالتالي، فإن المقالة الحالية تقدم معلومات حيوية وإرشادات بحث للباحثين في مجال طب الأسنان في بداية حياتهم المهنية وطلاب طب الأسنان. بالإضافة إلى ذلك، قمنا بجمع جميع المعلومات الأساسية المتعلقة بقواعد البيانات الإلكترونية المستخدمة عموماً في مجال أبحاث طب الأسنان تحت مظلة واحدة، التي ستكون مفيدة بالتأكيد لطلاب طب الأسنان والأطباء المقيمين والاستشاريين والباحثين العلميين.

الكلمات المفتاحية: البحث؛ استراتيجية البحث؛ قواعد البيانات؛ طب الأسنان؛ تعليم الأسنان

Abstract

A well-organized literature search is a fundamental requirement for research-based dental education. The execution of a literature search is not beneficial unless researchers possess basic knowledge about it. In this article, all basic strategies and research tools essentially

required for a literature search, including Boolean operators, correct use of keywords, database selection, and the evaluation of filtered data and limitations, are discussed. The present article offers vital information and literature search guidelines for early career dental researchers and dental students. In addition, it contains a collection of all the essential information related to the generally used electronic databases in dentistry research. This will be helpful for dental students, residents, consultants, and allied science researchers.

Keywords: Databases; Dental education; Dentistry; Literature search; Research; Search strategy

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Introduction

Over the last few years, research in dentistry has expanded tremendously. Accordingly, with increasing literature knowledge, the stress-free virtual availability of information in several search databases has broadened the diameter of evidence-based education.¹ At the same time, this achievement has resulted in a considerable research task for students, residents, and consultants in terms of relevant literature exploration.² Quantitative and qualitative research is an obligatory component of today's academic and professional life. Therefore, diving into an ocean of dental research literature without knowing the fundamental

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guidelines of literature search can pose a challenge for researchers.³ A wide distribution of information-seeking strategies related to dentistry is available in the form of standard textbooks, academic and non-academic courses, and digital networks.^{3,4} Currently, social media is setting a new trend in the development of the dental research. Tutorials, blogs, lectures, peer-reviewed articles, and research guidelines are easily available and have been publicized through social networking sites. However, social media communication has great influence on the merit of research publications.⁴

Literature search is the process of searching for relevant information and then critically reviewing it. The goal of an effective literature search is to save time, limit the total number of titles, maximize the number of relevant titles, and minimize the number to be read.⁵ A well-constructed search strategy is therefore key to an effective literature search. The search strategy must be logical and creative.⁶ The best approach is to start with a good research question (what you are going to research).⁷ A good research question can be designed using PICO criteria: P = population, I = intervention/exposure, C = comparison group/control, and O = outcome.⁸ Thus, the search strategy includes the key points of your research question in order to extract relevant results.⁹ The search strategy will account for all keywords and phrases, possible search terms, wildcard and truncated variations of search terms, and subject headings (where applicable).¹⁰

To ensure an evidence-based literature search, an adequately formulated research question is required together with the selection of correct databases. Keywords or phrases identified from the research question are used with Boolean and additional operators listed according to the database. For better success, the results should then be evaluated with filter or limitations application if necessary.¹¹

This review aims to provide information on the elementary guiding principles of a literature search in the field of dentistry that can constitute the ultimate source of information benefitting dental researchers.

Effective ways of literature search

Today, digital knowledge has gained prime importance in evidence-based literature search along with old-style publications procedure.¹² Frequently used online search engines offer open accessibility to journals either through cost-free or labelled ACP (article processing charges) for full-text articles, such as PubMed, DOAJ, Web of Science, and Scopus.^{13,14} The digital libraries of many institutes and colleges provide subscription-based accessibility to databases and printed or electronic journals through which relevant articles can be retrieved.¹⁵ Subsequently, this benefits academic societies in terms of economic aid related to research work for faculty members and affiliated students.¹⁶

Databases

Search engines differ in terms of accessibility, search format, required syntax, capability to build and save searches, and ability to obtain programmed updates.⁵ Parallel to database selection, the formation of a research

question is an essential task. Clinical problems should be identified and altered into answerable questions based on the commonly used PICO model.¹⁷ This is followed by the generation of a word list based on keywords from the question.⁷ For comfortable selection, databases are classified into general and subject-specific groups.

Major general databases are the primary source of dentistry literature. They provide inordinate resources of e-books, indexed and open-source journals, peer-reviewed articles, conference reports, case reports, review articles, protocols, and dissertations (Table 1).² Subject-specific databases provide additional resources. Oral science resources and dentistry databases that provide the principal subject-based multi-disciplinary research in dentistry are shown in Table 2.¹⁸

Among general databases for dental literature searches, PubMed is responsible for the leading medicine and biomedical science updates, including online in-press articles, while Scopus and Web of Science embrace online journal articles. PubMed and Google Scholar provide free access to dental research literature, while other foremost databases require a subscription. Broadly speaking, Google Scholar can help in retrieving articles by self-selected keywords from the articles and author name but mostly does not provide precise information for citation.¹⁹

Embase is a general bibliographic database that contains original as well as review articles, while Cochrane library focuses on information for systemic review in dentistry. Cochrane review groups offer access to records of randomized and non-randomized control trials. Most of the Cochrane Central data sources are PubMed, Embase, CINAHL, ClinicalTrials.gov, and the WHO's International Clinical Trials Registry Platforms. It deliver a great source of reviewing intervention in dentistry if the focus is on clinical trials.^{20–22} According to a recent investigation, a combination of Medline, Embase, Web of Science, and Google Scholar platforms is the minimum requirement for retrieving quality references on systemic reviews, whereas for subject-specific review topics, CINAHL, PsycINFO, and Cochrane databanks must be explored along with other major general databases.²³

Moreover, information resources excluding bibliographic databases are also present, which aid in framing literature searches. Guiding documents^{24–26} have acknowledged that searches should go further than bibliographic databases for systemic reviews since databases are not the only source of literature. However, these resources are considered as grey literature, providing benefits related to current updates but also possibly resulting in the inclusion of poor-quality articles.²⁷

Grey literature is material issued external to the traditional commercial and circulation networks.²⁸ It incorporates a vast collection of papers comprising documents such as case reports, policies, ethical and practice guidelines, theses, dissertations, conference abstracts, newsletters, and Blogs.^{28,29} It provides current updates of scientific research interventions and developments in the field of dentistry and also reduces publication bias. Comprehensive search topics related to social issues, policy, public health, and non-commercial publications involve searching grey literature sources.³⁰ A treasure trove of theses and dissertations are now

Table 1: Ground codes of commonly used databases in dental literature search.

	PUBMED	GOOGLE SCHOLAR	OID	COCHRANE	EMBASE	SCOPUS	WEB OF KNOWLEDGE
Boolean operator	AND, OR NOT	OR/, minus (-) i	AND, OR NOT	AND, OR, NOT	AND, OR NOT	AND, OR, NOT	AND, OR, NOT
Exact phrase	“Double quote”	No quotes needed	No quotes needed	“Double quote”	“Single quote”	“Double quote”, {Curly Brackets}	Bracket ()
Truncation	(*) sign at end	—	(*, \$) sign at end/mid	(*) sign at end	(*) sign at end/mid	(*) sign at end	(*) sign at end
wildcard	—	—	#, ?	?	#, ?	?	?, \$
Proximity	—	—	ADJ	NEAR/n, NEXT/n	ADJ	PRE/n, W/n	NEAR/x, SAME
Index terms	MeSH	—	Exp	MeSH	Emtree	- iii	- iii
Sub-headings	/sh [Mesh]	—	/sh	/sh	(/ds,/dd,/dv_) ii	- iii	- iii

i: Google Scholar does not offer advance literature search, Pipe (/) works similar like OR operator and minus (-) sign used for limitation instead of NOT, AND.

ii: Sub-heading in Embase.com applied only for disease/ds, drugs/dd, and devices/dv.

iii: Scopus & web of science does not include index terms and sub-headings.

accessible online in various databases such as ProQuest, British Library's Ethos Databases [<https://ethos.bl.uk/>], and Open Access Theses and Dissertations [<https://oatd.org>].²³ Embase and Web of Science provide access to indexed conference proceedings. The International Association of Dental Research (IADR) provides a distinct record of meeting abstracts to track down unpublished studies (Table 2).²³

Precise data extraction requires the appropriate selection of search terms or word phrases in amalgamation with the selected database's syntax guides. Relevant search terms selected from the designed question based on a PICO strategy result in minimizing bias and supplementary errors.⁹

Keywords or phrases

Keywords function as exploration terms for literature searches in a variety of databases while reflecting the vital concept of the research topic. The correct form of keyword or phrase is needed for the exploration of precise data assessment.²⁹ Single exploration terms are classified as a simple search, while a grouping of search terms or phrases is considered a compound search.³¹ *Index terms* are the control vocabulary words labelled as content in article

citation.³² These standard terms are used along with keywords or free-text words in primary databases to magnify the search span and acquire relevant outcomes.³² Index terms diverge according to forms of searching databases such as Medical Subject Heading (MeSH), which are used in MEDLINE and COCHRANE databases, Emtree® headings used for Embase, and so on (Table 1).^{30,32} These terms are hierarchical branched trees from broad stem to narrow root search terms (such as Operative dentistry, *streptococcus Mutans*, dental caries, restoration, restorative material). However, PubMed provides an additional advantage of “automatic term search” by adding specific MeSH terms automatically linked with keywords.³³ Similarly, Embase also provides an additional facility of vocabulary words, while in other databases, suitable vocabulary words should be customized.

Advance databases facilitate the execution of sensitive searches by providing narrower terms branching along with keywords in the title and abstract field. This results in a precise and specific article search.³⁴

Qualifiers are the sub-headings used when the literature search is broad or needs to specify a condition. A two-letter coded qualifier list is available for each MeSH in the MeSH browser of databases.³⁵ To elaborate, the combined use of

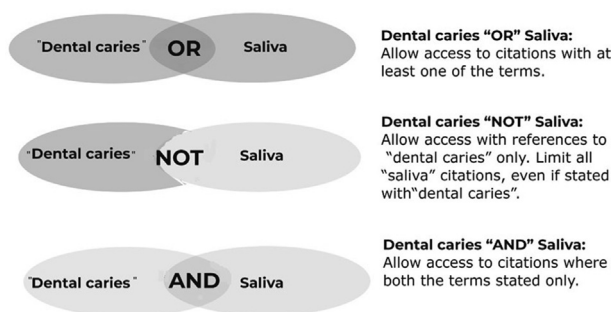
Table 2: Major resource of literature search in dentistry.

Resource Name	URL	Functional Characteristics
PubMed	https://pubmed.ncbi.nlm.nih.gov	It allows access to MEDLINE and other health sciences literature associated with dentistry.
OID Medline	https://www.ovid.com/specialties/dentistry	It provide access to resources related to orthodontics, endodontics, dental surgery, evidence-based treatment, etc. It also offers full-text resources by Wiley, Oxford university press, Lippincott.
Cochrane Library	http://www.cochranelibrary.com	Allow access to evidence-base dental researches, full-text systemic reviews of Cochrane oral health group.
Scopus	https://www.scopus.com/home.uri	Provide access to integrative research in dentistry, high index and peer-reviewed journals, e-books, conference materials.
Web of Science (ISI)	https://login.webofknowledge.com	Provide useful resources associated to dental ethics, dental anxiety, health psychology
Embase	www.embase.com/login	Access to articles on drug research, pharmacology, and medicine.
Google Scholar	https://scholar.google.com/	Allow quick access to all electronic emergent scientific field publication resources and limited advanced search.

the Boolean operator, keywords, and MeSH words along with field codes is given together as an example (“Socket inflammation” [tw] OR “Dry socket” OR “alveolar osteiti*” [mh]) AND (Management [tiab] OR Prevention OR therap* [tiab]). This search strategy will retrieve all the articles related to the dry socket and its management. The MeSH word [mh] is used along with the text word [tw], and the “Title/Abstract” field code is used as a limitation with the truncation sign (*).

Boolean operators

Boolean logic is the functional tool used to associate two or more search terms or keywords to augment the research outcomes. The three main Boolean operators are “AND”, “OR”, and “NOT”.⁷ Boolean operators are case sensitive and must be typed in upper case (capital letters).



BOOLEAN OPERATORS

Figure 1: Representation of Boolean operator execution using various keywords of literature search.

The operator ‘AND’ is used to rectify citations that comprise all the search phrases, while ‘OR’ is used to retrieve either of the search terms it is placed between. The operator “NOT” is used to exclude search terms and limit citations. The navigation of “AND” and “NOT” operators is to constrict the search span; however, the “NOT” operator is rarely used since a coincidental limitation for needed citations exists.³⁶ Contrarily, the operator ‘OR’ broadens the search span as explained in Figure 1. All three operators are used by the majority of primary databases. In Google Scholar, AND and NOT do not apply, it considers by default while the OR function is applicable. For limitation, the minus (–) sign is used in Google.³⁷

Additional symbols are used sideways with Boolean operators such as brackets “()”, truncation signs (*, \$), replacement wildcard (*, ?, #), and double speech marks (“ ”).³⁸ Bracket placement is required to cluster all the alternative expressions, when both AND and OR operators are used together in the same database search bar, for example, (awareness OR knowledge OR information) AND fluorosis. The truncation symbol varies within search databases such as Scopus, OVID scaffolds (Medline, Embase, PsycINFO), COCHRANE, Web of Science, and PROQUEST. EBSCO uses an asterisk (*), while Google Scholar does not offer the parenthesis function.³⁸ However, it eventually broadens the search span by identifying similar words. To apply the truncation function, the (*, \$) symbol is entered at the root end of the search term; for example, ‘dental caries’ AND child* or ‘dental caries’ AND child\$ would retrieve citations with dental caries and child, children, and childhood.¹² The wildcard (*,?, #) sign is used to replace a single letter in a word when there are alternate spellings of the same keyword. For instance, to search for literature on the question of *oral health*

Table 3: Subject-specific resources of dentistry.

Resource Name	URL	Functional Characteristics
BIOSIS Previews	thomsonreuters.com/en/products-services/scholarlyscientificresearch/scholarly-search-and-discovery/biosis-previews.html	Life science literature, dental pharmacology.
Cumulative Index to Nursing and Allied Health Literature (CINAHL)	health.ebsco.com/products/the-cinahl-database/allied-health-nursing	Nursing and allied health databases
PsycINFO	http://www.apa.org/pubs/databases/psycinfo/	Social science, education, psychology and psychiatry databases
International Association of Dental Research (IADR)	https://www.iadr.org https://iadr.abstractarchives.com/	Driving dental, oral and craniofacial research
Joanna Briggs Institute EBP	journals.lww.com/jbisrir/pages/default.aspx	Nursing and allied health databases, Evidence based recommended practices, Evidence summaries, Systematic reviews, Consumer and practice information sheets, Systematic review protocols, and Technical reports.
ProQuest Dissertations and Theses – UK & Ireland	www.proquest.com/productsservices/pqdt_uk_ireland.html https://www.proquest.com/products-services/dissertations	Dissertations and theses
Sociology Abstract	https://library.udel.edu/databases	Dental care, contributing factor of health
Techstreet	https://www.techstreet.com/	Suggest ethics for dental materials and equipment.
Factiva	https://professional.dowjones.com/factiva/	Business information and newspaper reporting dentistry related topics
HeathSTAR	https://healthstarcom.com/	health care delivery, administration, technology

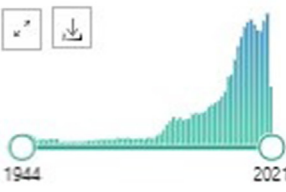
PubMed.gov (Dental Implants) AND (Dental Implants) Search

Advanced Create alert Create RSS User Guide

Save Email Send to Sorted by: Most recent Display options

MY NCBI FILTERS 42,708 results

RESULTS BY YEAR



TEXT AVAILABILITY

Abstract

Free full text

Full text

ARTICLE ATTRIBUTE

Associated data

ARTICLE TYPE

Books and Documents

Clinical Trial

Meta-Analysis

Randomized Controlled Trial

Review

Systematic Review

PUBLICATION DATE

1 year

5 years

10 years

Custom Range

Additional filters

Reset all filters

1 Effect of opaque eye coverage on anxiety in candidates for surgical removal of impacted third molars: a randomized clinical trial.

Cite Moaddabi A, Hasheminia D, Bagheri S, Soltani P, Patini R.

Share Oral Surg Oral Med Oral Pathol Oral Radiol. 2021 Mar 31;S2212-4403(21)00169-3. doi: 10.1016/j.oooo.2021.03.019. Online ahead of print. PMID: 34030999

2 Application of digital prosthodontics and connective tissue grafting in the management of peri-implant mucosal recession around a malpositioned 1-piece implant: A clinical report.

Cite Yang J, Liu Q, Shiba T, Ji C, Iwata T, Jiang T.

Share J Prosthet Dent. 2021 May 21;S0022-3913(21)00161-X. doi: 10.1016/j.prosdent.2021.03.013. Online ahead of print. PMID: 34030887

3 Immediate Teeth in Fibulas: Expanded Clinical Applications and Surgical Technique.

Cite Williams FC, Hammer DA, Wentland TR, Kim RY.

Share J Oral Maxillofac Surg. 2021 Apr 19;S0278-2391(21)00326-8. doi: 10.1016/j.joms.2021.04.005. Online ahead of print. PMID: 34029526

4 Horizontal alteration of anterior alveolar ridge after immediate implant placement: A retrospective cone beam computed tomography analysis.

Cite Hyun YK, Lee CY, Keerthana S, Ramasamy S, Song SY, Shim JS, Ryu JJ.

Share J Adv Prosthodont. 2021 Apr;13(2):117-125. doi: 10.4047/jap.2021.13.2.117. Epub 2021 Apr 27. PMID: 34025960 [Free PMC article.](#)

5 Effects of inter-implant distance on the accuracy of intraoral scanner: An *in vitro* study.

Cite Thanasisuebwong P, Kulchotirat T, Anunmana C.

Share J Adv Prosthodont. 2021 Apr;13(2):107-116. doi: 10.4047/jap.2021.13.2.107. Epub 2021 Apr 27. PMID: 34025959 [Free PMC article.](#)

6 Comparative evaluation of peri-implant stress distribution in implant protected occlusion and cusally loaded occlusion on a 3 unit implant supported fixed partial denture: A 3D finite element analysis study.

Cite Acharya PH, Patel VV, Duseja SS, Chauhan VR.

Share J Adv Prosthodont. 2021 Apr;13(2):79-88. doi: 10.4047/jap.2021.13.2.79. Epub 2021 Apr 27. PMID: 34025956 [Free PMC article.](#)

7 Therapeutic Potential of Vasoactive Intestinal Peptide and its Derivative Stearyl-Norleucine-VIP in Inflammation-Induced Osteolysis.

Cite Eger M, Liron T, Hiram-Bab S, Awida Z, Giladi E, Dangoor D, Fridkin M, Kohavi D, Gozes I, Gabet Y.

Figure 2: Literature search strategies through the application of various filters using the PubMed database.

Figure 3: Application of additional filters for literature search using the PubMed database.

assessment in pregnant women, the search term by using wildcard/truncation would be ["oral health" AND "pregnant wom*n"] or [(oral health) AND (pregnant wom? n)].^{39,40} Consequently, this would search all the articles of oral health assessment with both pregnant woman and pregnant women keywords, where there is American and British spelling variation.⁴⁰ However, this symbol does not produce many variations in databases. Quotation marks denote the beginning and end of the keyword. Inverted commas are applied when a group of words depicts the same expression, for example, "dental materials" (see [Tables 1 and 3](#)).³⁴

Moreover, bibliographic databases with advanced search facilities have provided additional operators that find relevant keywords within the given number of words. These functions are mostly involved in high-quality searches, particularly for review papers.³⁶

Proximity operators are false Boolean operators such as NEAR, WITH, WITHIN, and ADJ. These are offered by advanced databases to support search statement fabrication. This function is not offered by PubMed. However, AJD is used by Ovid; NEAR (N#) and WITHIN (W#) are used by EBSCO databases, whereas the COCHRANE Library, ProQuest, and Web of Science use NEAR.³⁸ The number is used along with the proximity operator to direct the database to find the keyword up to the given number in a word phrase.³⁶ For instance, "Composite N2 resin" will explore both the terms in any way with up to two words in between, such as composite resin, composite-based resin, and composite restorative resin.

After the application of relevant search strategies, the obtained data are analysed for precision and validation of search results. The majority of databases suggest short phrases or single search term usage, which results in the extraction of many unsuitable material for researchers.⁴¹ Search filters are established to overcome this difficulty as well as support the formation of review questions and include/exclude studies. While accurate usage of keywords develops initial filtration of relevant articles,^{42,43} inclusion criteria determine the selection of relevant and irrelevant studies.⁴²

Evaluation of search results and filter usage

Comprehensive and relevant search outcomes require a thorough assessment of the searched literature. It is particularly useful to read the abstract, to get a clearer image of what can be found in the article. This will assist in narrowing down the material most likely to be significant. *Search Filters* are designed to extract productive search results. These filters differ in each search engine to continue the imperative enhancement of the search competencies. Boolean operators mainly form affiliations among search words or phrases but also work sideways as a search filter to sharpen the productivity of the search.^{44,45} It is also important to categorize the search limits provided by databases that are well adapted by dental researchers broadly, such as publication date, peer-reviewed, articles, and publication type. All search engines consolidate statistics about their official papers into particular fields. These field filters have a high sensitivity to identify significant search material in the databases, such as Author, Title, Abstract, Subject, Full-text article, All except full text, and Publication name.⁴⁶ These filters are comparatively informal with basic searches as compared to advanced searches. However, effort should still be made to learn the basics tools of literature search.⁴⁷

Regarding additional filter features among most frequently used general databases, PubMed has recently added more default filters on the sidebar. These can be used to assess several more variables, such as species, language, sex, subject, journal, and age. These additions are important for narrowing the materials available in the PubMed archive ([Figure 2](#)).⁴⁸

In order to add these filters, the following steps are suggested:

- Select a category on the left side, for example, "Article type", "Species", and "Language".
- Within each selected category, select the filters you want to add to your Filters menu, such as "Journal article", "Multicenter study", and "Clinical study".
- Click on "Apply" to add these selected filters to the main filters menu and close the pop-up.
- To apply the filter, click on additional filters in the menu.
- A separate window of all filter options will now be visible, as shown in [Figure 3](#).

Dental students and researchers face various challenges in the use of databases, and they require adequate training in this from professional librarians. Every institute should make such training mandatory prior to any postgraduate or research-based programs. In this way, students can improve their skills and gain confidence in running an effective literature search using various biomedical databases.

Limitations

This review paper has accounted for mainly those researchers who are beginners or planning to begin with dental research. Although it provides a decent amount and quality of information, it is restricted to a general literature search rather than detailed discussion on literature searches for systemic

reviews. Further, to our knowledge, few authors have produced research or review papers related to dental literature search strategies. As a result, there is a limited citation of references associated with dental literature searches.

Conclusion

A literature search is an essential part in the execution of good-quality dental research. It helps to identify the overall study design and methodology, population sampled, sampling techniques, methods of analysis, and related calculations. It also aids in determining the effects of various independent variables on dependent outcomes and the strengths or weaknesses of past studies, for the improvement of futures studies. A researcher involved in research-based dentistry will find it helpful to develop and polish their skills under effective guidelines of the literature search strategy. Information about comprehensive biomedical and scientific databases and the implementation of fundamental research tools will improve literature search in dentistry. Knowledge of such search tools will help the dental community and researchers retrieve competent references. As the literature reviewing process provides knowledge about current updates in the field of dentistry, it offers networks for researchers to connect through globally. The basic knowledge of literature search strategies is thus helpful for both new and experienced dental researchers.

Recommendations

This review provides knowledge on overall literature search strategies for beginner researchers in the field of dentistry. Articles containing evidence on advanced literature searches associated with systemic reviews and studies related to the development of review questions following designs other than PICO (such as SPIDER and SPICE) are recommended for further reading. This type of literature benefits undergraduate students and general dental practitioners who plan to explore dental research and education.

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Conflict of interest

The authors have no conflict of interest to declare.

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The authors confirm that this editorial had been prepared in accordance with COPE roles and regulations. Given the nature of the editorial, the IRB review was not required.

Authors' contributions

ZK proposed the study design and literature search; RT worked on the data acquisition and drafted a major part of

the manuscript; ZK, RT, FYA, and KA collected, organized, and interpreted the data and wrote some parts of the manuscript; ZK and MSZ held general discussions and critically reviewed the manuscript. All authors have critically reviewed and approved the final draft and are responsible for the content and similarity index of the manuscript.

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