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Analysis of research trends in Korean dentistry journals by assigning MeSH to author keywords

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Abstract

Researchers seek to identify optimal journals for submission based on their studies but tend to rely on journal impact factors or scientific journal rankings. We investigated research trends by selecting high-frequency words from author keywords (AKs), analyzing subject areas, and performing quantitative data analysis of Korean dental journals. Consequently, we suggest a method for choosing journals that fit a specific subject area.

We used a corpus of 9 Korean dentistry journals regarded in Korea as quality internationally approved journals. AKs occurring more than 10 times were assigned to Medical Subject Headings (MeSH) terms and subcategories, which were then categorized using the MeSH tree structure. KnowledgeMatrix Plus and VOSviewer were used to analyze network relationships, density, and clustering.

The AKs were of 7527 types, 15,960 terms, and formed 54 clusters. The AKs with 10+ occurrence were 199 types, 4289 terms, and formed 9 clusters. Assigning the AKs with 10+ occurrence to MeSH terms led to expanding 732 types of AK terms into 249 types with 9 clusters and 4268 links. Core study areas over the past 10 years were facial asymmetry, a topic under oral surgery and medicine, and orthognathic surgery focused on mandibular fractures, followed by shear bond strength of zirconia. Analyzing 16 MeSH subject categories, we found that the "analytical, diagnostic and therapeutic techniques and equipment" category had the largest distribution of AKs (40.7%). This was followed by "diseases" (21.2%) and "anatomy" (14.90%). The orthognathic surgery cluster was the largest, followed by the shear bond strength cluster. Dental implants is a core area with strong links to high-occurrence words, such as cone-beam computed tomography and mandible, which were distributed in the order of The Journal of Advanced Prosthodontics (37.8%) and Journal of Periodontal & Implant Science (30.6%). Five clusters were closely packed in the center, 2 clusters were formed above the center, 1 cluster was formed below the center, and a cluster on the right was widespread.

Cluster analysis using AKs and MeSH may be a good analytic method for researchers to determine expanding research areas and select optimal journals for paper submission.

Abbreviations: AK = author keyword, CBCT = cone-beam computed tomography, JCR = journal citation report, JIF = journal impact factor, MeSH = Medical Subject Headings, NLM = national library of medicine, PMC = PubMed central, SJR = scientific journal ranking, WoS = Web of Science.

Keywords: co-word analysis, dentistry, medical subject headings, network analysis clustering, subject categories

1. Introduction

Researchers strive to publish their manuscripts in journals with high journal impact factors (JIFs) from Journal Citation Reports (JCRs; https://jcr.clarivate.com/) because it may

influence their reputation and funding. JIF is irrelevant to the quality of individual articles and faculty research assessment, which aim to consider both productivity and research impact.[1] However, this phenomenon is worsening. It is important for researchers to identify the optimal journals for submission based on the specific subject areas of their study. If researchers want to decide carefully, it is important that the subject area appears in the aims and scope of the submission guidelines and that they screen the sector-specific impact factors from citation index databases.

The items to be checked after several target journals have been decided are JIF ranking, CiteScore scores (https://www.scopus.com/), JCR Quartiles, and Scientific Journal Rankings (SJR; https://www.scimagojr.com/journalrank.php) in the field. These are also related to subject areas. The selection of the journal for submission may vary depending on the circumstances of individual researchers. Subsequently, if the scope of the journal to be to submitted is narrowed, it is submitted in consideration of average time to first decision, average acceptance rate, average time to publication, etc.

Depending on the research trends in the scholarly community, journals may be split into new journals and renamed; in such cases, the subject areas in the aims and scope of the journal are rewritten. It is important for researchers to understand research trends and key considerations in their field through bibliographic analysis of their studies for the journal.

Bibliometrics is an area of study that mathematically and statistically analyzes the characteristics of papers, identifying their traits, and forms of knowledge.

Bibliometrics have been used to understand microlevel research trends covering papers and authors, macrolevel trends covering research institutions and even entire countries. It also aims to understand the knowledge structure of the academic sector.[2]

Subject keywords are predetermined word(s) and/or phrase(s) used to describe a specific concept or idea. Bibliometric analysis of subject keywords identifies knowledge structures of research fields.[3]

Author keywords (AKs) are keywords or short phrases provided by the authors after the abstract that capture the main topics of the article; there are typically 3 to 10 AKs per paper. In particular, AKs are widely recognized vocabulary terms in the given subject area; they reflect the central topic of the article and are thus written accurately and precisely.

Especially when analyzing terminology that occurs in articles, AKs help to identify article contents. AKs are important to researchers for proper circulation of their articles to interested readers. The International Committee of Medical Journal Editors made the following recommendations in 2007: "Terms from the Medical Subject Headings (MeSH) list of Index Medicus should be used; if suitable MeSH terms are not yet available for recently introduced terms, present terms may be used".[4]

MeSH is controlled vocabulary of biomedical terms used to describe the subjects of each journal article in the PubMed/MEDLINE databases. MeSH was developed from the U.S. National Library of Medicine (NLM). MeSH terms are arranged hierarchically by subject categories with more specific terms arranged beneath broader terms.[5]

Therefore, frequency analysis of AKs and subject keywords can be used to demonstrate close relationships between subjects, and the frequency of co-occurring words can be used to visually depict the subject area. This can also be used to identify specific areas of research uniquely being studied in a given subject area, specific areas shared with other journals, and trends of change depending on the time periods of terms through time-series analyses.

The subject areas of dentistry can be largely divided into basic dentistry, clinical dentistry, and convergent areas of study. In the past 10 years, convergence of dentistry with other subject areas, such as computers and bioengineering, has grown, and new digitally enabled technologies have been applied. Particularly, the field of Oral Surgery & Medicine has shown rapid growth. This study assigned AKs according to MeSH for 10 years of journal articles in dentistry and categorized them using the MeSH hierarchy structure. Furthermore, using the subject categories and tree numbers in the MeSH terms to calculate the occurrence and frequencies of terms in specific categories enabled analysis of yearly and journal-specific characteristics, as well as differentiators between categories. There are tens of thousands of scholarly journals to select subject areas from.

The purpose of this study was to investigate research trends by selecting high-frequency words from AKs, analyzing subject areas, and performing quantitative data analysis of Korean dental journals to find the most suitable journal for article submission.

2. Methods

We used a corpus of the 9 Korean dentistry journals indexed in PubMed Central (PMC) and KoreaMed. A paper published in a journal indexed in PMC or KoreaMed is regarded in Korea as a paper of internationally approved quality. The 10-year period from 2010 to 2019 was covered in this study. Categorization of the literature was conducted with MeSH terms for AKs that occurred more than 10 times. Furthermore, this study analyzed co-occurring terms through frequency and network analysis, clustering the results, and visualizing the relationships between research topics (Fig. 1).

2.1. Methodology for assigning AKs to MeSH

The analysis of co-occurring words utilizes full text, abstracts, and AKs as its main study material; the singular, plural, and short forms may create issues. The incompleteness, noise, and inconsistency of data are problems that occur frequently when using academic literature databases as research materials. In particular, in these cases, the data go through preprocessing, such as singular/plural stemming, in a systematic manner.[6] However, the application of a controlled vocabulary, such as a thesaurus, is required to secure the reliability of data by more accurately refining acronyms, similar concepts, and synonyms. As the first step, this study mapped MeSH terms using 199 of a total of 210 AKs that occurred more than 10 times.

At NLM, they examine journal articles and assign to each the most specific MeSH terms applicable—typically 10 to 12. Applying the MeSH vocabulary ensures that articles are uniformly indexed by subject, whatever the authors' words. Searching a term only as a MeSH term in PubMed, it must be tagged using the search field, for example, [mh] for MeSH terms.[7] For all MeSH terms in this study, the first letter of the word was capitalized and single quotation marks were used, for example "Neoplasms by Histologic Type".

According to the indexing principles of NLM MeSH, we assigned a term that does not match MeSH out of 210 AKs as MeSH. Two researchers (JSN and JJN) independently assigned MeSH to AKs with reference to each title and abstract and resolved the discrepancies through discussion.

1) Neoplasms was assigned to "Neoplasms by Histologic Type" and "Neoplasms by Site". In other words, the oral squamous cell carcinoma was "Carcinoma, Squamous Cell AND Mouth Neoplasms".
2) In some cases, coordinated terms using 2 MeSH terms were possible. For example, shear bond strength is "Dental Bonding AND Shear Strength", and orthodontic mini-implant was "Dental Implants AND Orthodontic Appliance Design".
3) When subheading terms were combined, dental treatment was expressed as "Dental Care", orthodontic treatment was expressed as "Orthodontics/therapy" and surface treatment was expressed as "Surface Properties".

AKs occurring more than 10 times (210 types, 4437 occurrences) were searched on the MeSH browser (https://meshb.nlm.nih.gov/) and were assigned to MeSH headings by searching for similar concepts (synonyms, analogous terms, acronyms, singular/plural processing, etc.) or MeSH entry terms. This allows for the analysis of AKs that are MeSH entry terms occurring less than 10 times. After vocabulary control of AKs using MeSH, there were 71 new AKs occurring more than 10 times. For example, the AKS used as "surgical procedure" occurred 6 times but was included as "Oral Surgical Procedures" 13 occurrences.

As the second step, MeSH headings were assigned for AKs with occurrence frequencies of 10 or less, classified as MeSH entry
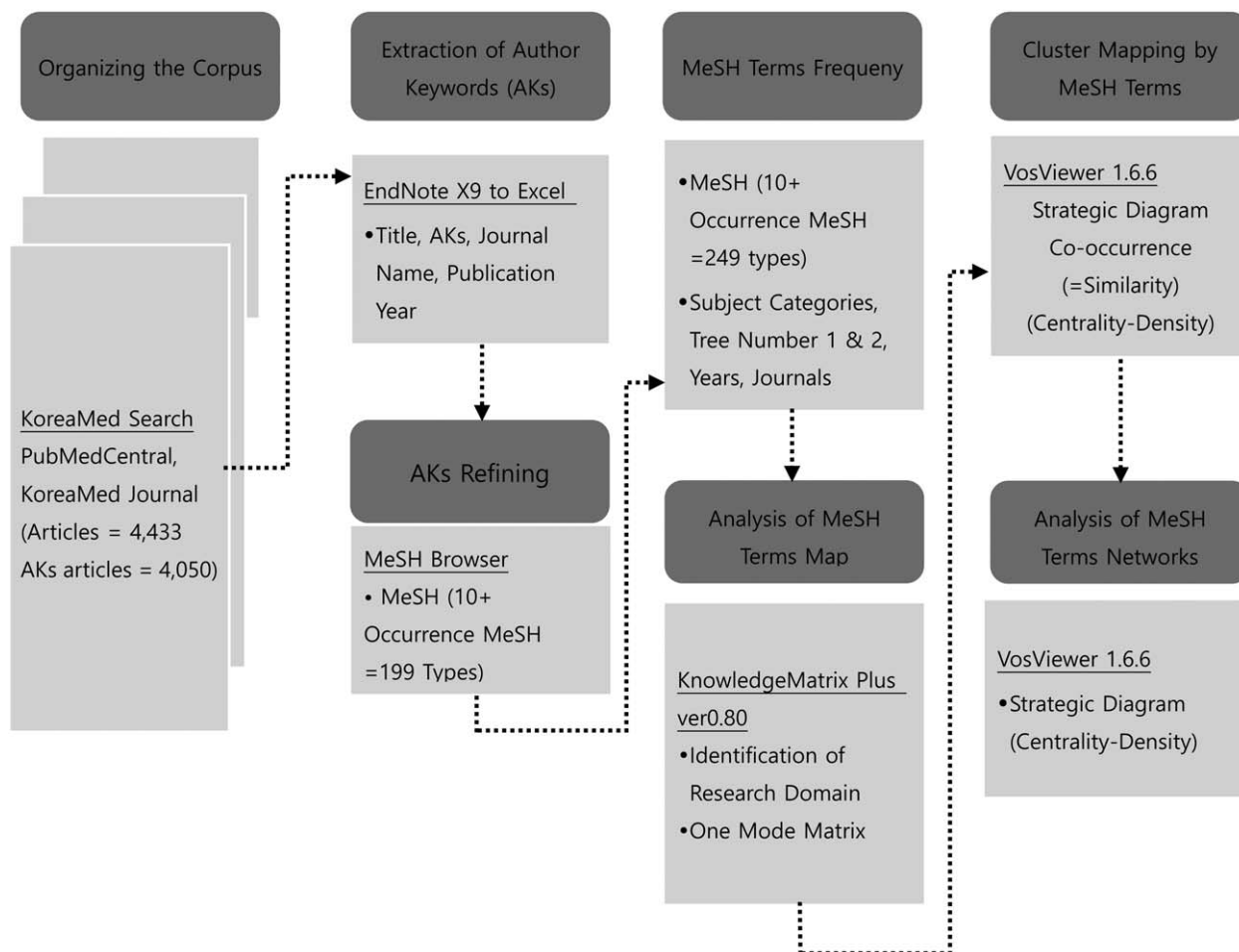
Figure 1. Study identification diagram for the experimental procedure. AK = author keyword, MeSH = Medical Subject Headings.

terms. Dental implants, dental implant, implant, and implants are synonyms of dental implants. In MeSH, these terms are called entry terms. The preferred term among these is "Dental Implants", and in the context of MeSH, they are referred to as MeSH headings. This study used MeSH headings to control vocabulary for all MeSH entry terms using the MeSH indexing method to secure the reliability of the data.

2.2. Frequency analysis methodology and co-occurring term analysis methodology

KnowledgeMatrix Plus ver.0.80,[8] which supports scientometric network analysis, was used for the frequency analysis of AKs and MeSH terms and to calculate the 1-mode co-occurrence frequency matrix.

Afterwards, Visualization of Similarities (VOSviewer) version 1.6.6 was used to analyze the networks between MeSH terms through density, importance, and clustering analysis. VOSViewer was used to calculate the similarities between categories based on the co-occurrence matrix, cluster terms based on the results, and express the results in a 2-dimensional clustering map and network visualization. Then, a density map was compiled by indicating the density of each term based on its occurrence frequency.[9]

3. Results

3.1. Publication trends

The total number of papers in the 9 types of analyzed journals identified in this study for the period of 2010 to 2019 was 4433. The 9 journals included 3 SCIE journals, 6 Scopus journals, and 3 PMC journals among Korean dental journals. MeSH terms assigned to subject category names in the NLM catalog (https://www.ncbi.nlm.nih.gov/nlmcatalog)[7] were specific, but those followed by SCOPUS and Web of Science (WoS) were relatively broad subject categories. JIF rankings were Korean Journal of Orthodontics (Korean J Orthod), Journal of Periodontal & Implant Science (J Periodontal Implant Sci), and The Journal of Advanced Prosthodontics (J Adv Prosthodont). SJR rankings were Korean J Orthod, J Periodontal Implant Sci, Imaging Science in Dentistry (Imaging Sci Dent), Journal of the Korean Association of Oral and Maxillofacial Surgeons (J Korean Assoc Oral Maxillofac Surg), and J Adv Prosthodont (Table 1).

Among the 4433 articles analyzed, there were a total of 4050 articles with AKs (7,527 types, 15,960 AKs), averaging 3.94 per article. In terms of yearly journal-specific trends of AKs, J Adv Prosthodont showed a significant change in AKs from 194 to 310 between 2012 and 2013. This is due to an increase in the total

Table 1

Descriptive statistics on the 9 Korean dentistry journals in 2010–2019.

Journals	Subject categories		Indexed database	Total no. of articles (average)	No. of articles with author keywords	No. of author keywords (%)	Journal impact factors	CiteScore	SJR
	MeSH of National Library of Medicine catalog	SCOPUS (Web of Science)							
Archives of craniofacial surgery (Arch Craniofac Surg). vol. 13, no. 1 (2012)–vol. 20, no. 5 (2019); a Journal of the Korean cleft palate-craniofacial association (J Korean Cleft Palate Craniofac Assoc). vol. 11, no. 1 (2010)–vol. 12, no. 2 (2011)	• Craniofacial abnormalities/surgery • Head/surgery* • Reconstructive surgical procedures	• Otorhinolaryngology, surgery	• KoreaMed PMC • SCOPUS (2019-ongoing)	433 (43.3)	395	1299 (8.14)			
Imaging science in dentistry (imaging sci dent). vol. 41, no. 1 (2011)–vol. 49, no. 4 (2019); a Korean journal of oral and maxillofacial radiology (Korean J Oral Maxillofac Radiol). vol. 40, no. 1 (2010)–vol. 40, no. 4 (2010)	• Radiography • Radiography, dental* • Stomatognathic diseases/diagnostic imaging	• General dentistry, radiological and ultrasound technology, radiology nuclear medicine and imaging	• KoreaMed • PMC • ESCI • SCOPUS/ CiteScore • SJR	410 (41.0)	399	1401 (8.78)		1.21	0.44
The journal of advanced prosthodontics (J Adv Prosthodont). vol. 2, no. 1 (2010)–vol. 11, no. 6 (2019)	• Dental implantation* • Dental materials • Dental prosthesis	• Dentistry, oral surgery & medicine (dentistry (miscellaneous), oral Surgery)	• KoreaMed • PMC • SCIE • SCOPUS • CiteScore • SJR	580 (58.0)	573	607 (16.33)	0.381	1.7	0.23
Journal of dental anesthesia and pain medicine (J Dent Anesth Pain Med). vol. 15, no. 1 (2015)–vol. 19, no. 6 (2019); a Journal of the Korean dental society of anesthesiology (J Korean Dent Soc Anesthesiol). vol. 10, no. 1 (2010)–vol. 14, no. 4 (2014)	• Anesthesia, dental* • Pain management		• KoreaMed • PMC	338	325	1298 (8.13)			
Journal of the Korean association of oral and maxillofacial surgeons (J Korean Assoc Oral Maxillofac Surg). vol. 38, no. 1 (2012)–vol. 45, no. 6 (2019); a Journal of the Korean association of oral and maxillofacial surgeons (J Korean Assoc Oral Maxillofac Surg). vol. 36, no. 1 (2010)–vol. 37, no. 6 (2011)	• Maxillofacial injuries/surgery* • Oral surgical procedures	• Oral Surgery, surgery	• KoreaMed • PMC • SCOPUS • CiteScore • SJR	666 (66.6)	580	2166 (13.57)		0.71	0.3
Journal of periodontal & implant science (J Periodontal Implant Sci). Vol. 40, no. 1 (2010)–vol. 49, no. 6 (2019)	• Dental implantation • Dental implants • Periodontal diseases/therapy*	• Dentistry, oral surgery & medicine (oral surgery, periodontics)	• KoreaMed • PMC • SCIE • SCOPUS • CiteScore • SJR	445 (44.5)	372	1496 (9.37)	0.413	1.39	0.73
				465 (46.5)	403	1527 (9.57)	0.414	1.49	1.05

Table 1
(continued).

Journals	Subject categories		Indexed database	Total no. of articles (average)	No. of articles with author keywords	No. of author keywords (%)	Journal impact factors	CiteScore	SJR
	MeSH of National Library of Medicine catalog	SCOPUS (Web of Science)							
Korean journal of orthodontics (Korean J Orthod). vol. 42, no. 1–vol. 49, no. 6 (2019); aKorean journal of orthodontics (Korean J Orthod). vol. 40, no. 1 (2010)–vol. 41, no. 6 (2011)	• Malocclusion/therapy* • Orthodontics/methods*	• Dentistry, oral surgery & medicine (orthodontics)	• KoreaMed • PMC • SCIE • SCOPUS • CiteScore • SJR	599 (59.9)	565	2140 (13.41)			
Maxillofacial plastic and reconstructive surgery (Maxillofac Plast Reconstr Surg). vol. 36, no. 2 (2014)–vol. 41, no. 1 (2019); aJournal of Korean association of maxillofacial plastic and reconstructive surgeons (J Korean Assoc Maxillofac Plast Reconstr Surg). vol. 32, no. 1 (1990)–vol. 36, no. 1 (2014)	• Oral Surgical procedures* • Reconstructive surgical procedures		• ESCI						
Restorative dentistry & endodontics (Restor Dent Endod). Vol. 37, no. 1 (2012)–vol. 44, no. 4 (2019); aJournal of Korean academy of conservative dentistry (J Korean Acad Conserv Dent). vol. 35, no. 1 (2010)–vol. 36, no. 6 (2011)	• Dental restoration, permanent* • Dentistry • Endodontics*			497 (49.7)	438	2,026 (12.69)			
Total				4433 (443.3)	4050	15,960 (100.00)			

a Preceding journal names. SJR = Scientific Journal Rankings, MeSH = Medical Subject Headings
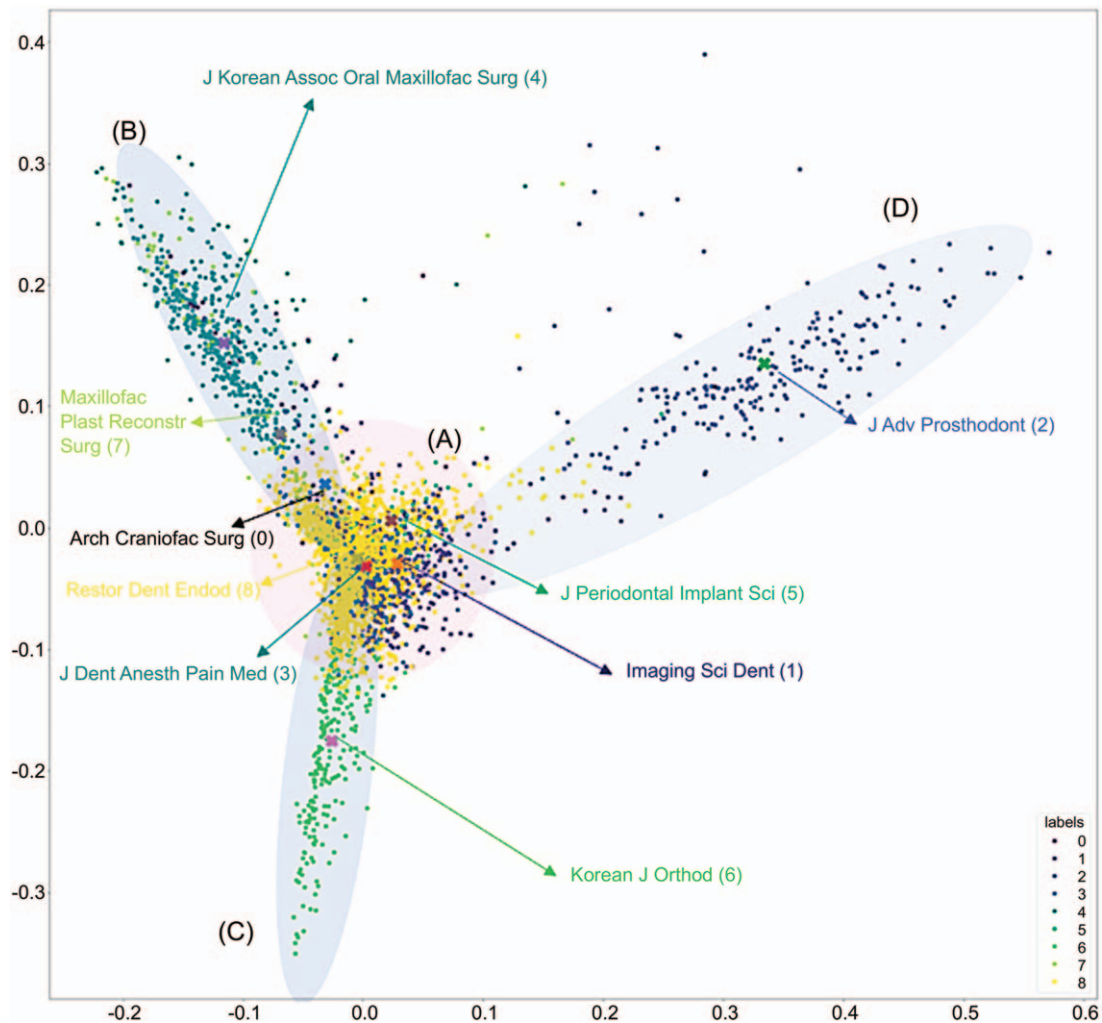
Figure 2. Article title clustering with K-means algorithm using Natural Language Processing. NLP = Natural Language Processing.

number of articles from 44 in 2012 to 73 in 2013; from 2013 to 2018, an average of 70.3 articles were published. On the other hand, J Korean Assoc Oral Maxillofac Surg published an average of 66.6 articles per year (Table 1); however, 51 were published in 2018, which is a significant decrease in AKs. Archives of Craniofacial Surgery (Arch Craniofac Surg)'s production volume is increasing, while Maxillofacial Plastic and Reconstructive Surgery (Maxillofac Plast Reconstr Surg)'s is decreasing (Supplemental Material 1, http://links.lww.com/MD/E871).

3.2. Clustering for co-occurring words in article titles

After categorizing the 9 journals, we conducted text clustering with the K-means algorithm using NLP with Python (http://www.python.org) clustering for co-occurring words in article titles; we found that the terms were distributed in 3 axial directions. Five clusters were closely packed in the center (A group), 2 clusters were formed above the center (B group), 1 clusters was formed below (C group), and a cluster on the right was widespread (D group) (Fig. 2).

The dataset consisted of 4050 articles from 9 journals. The 9 journals were classified into different categories, and the terms that simultaneously appeared in study titles were subject to text clustering with the K-means algorithm.

Clustering results showed that terms are distributed in 3 different directions. The K-means clustering algorithm is a simple clustering algorithm that aims to identify the centre of each cluster. It does this by searching for a point that minimizes the distance between the center and all the points in the cluster.

The terms in the titles of J Adv Prosthodont, Korean J Orthod, and J Korean Assoc Oral Maxillofac Surg had different characteristics from those in the titles of other journals. This means that the journals have unique subject areas. J Periodontal Implant Sci is composed of terms that are commonly used in each journal, and it is highly likely to be a core journal because it can be seen that the distance between each journal is close. J Periodontal Implant Sci has 2018 JIF of 1.472 among SCIE journals.

The 7,527 types of 15,960 AKs are indicated by 34 clusters and 5406 links. All AKs were visualized through the clustering map and network visualization using VOSViewer. Co-occurring AKs were distinguishable, but their relationships were difficult to identify (Fig. 3(a)). The color of an AK in the map depends on the number of AKs in its neighborhood and on their importance.[9]
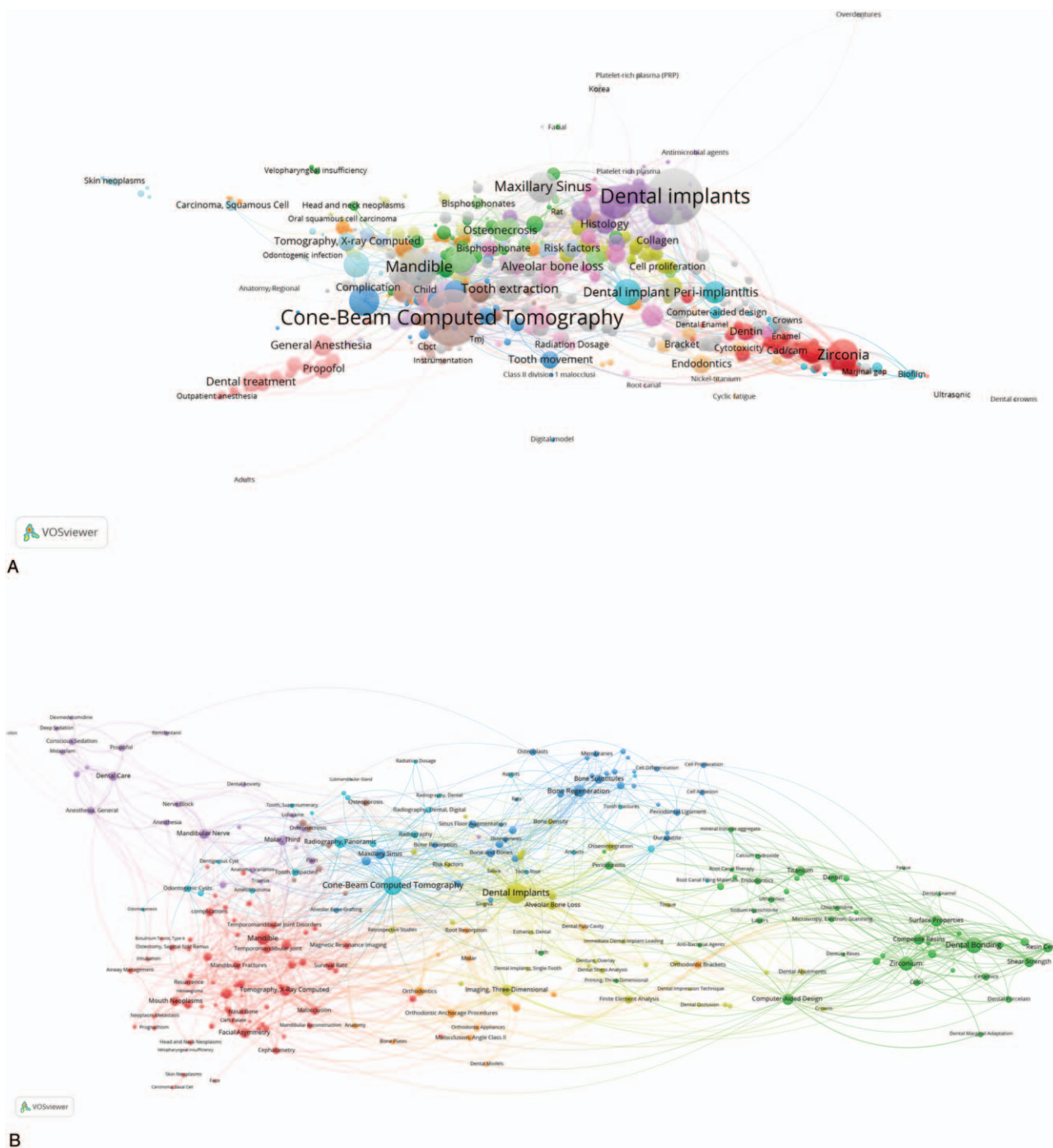
Figure 3. Co-word network map of author keywords and Medical Subject Headings terms. MeSH = Medical Subject Headings.

The most frequent AKs were in the order of cone-beam computed tomography (CBCT) (235 occurrences), dental implants (185 occurrences), and mandible (98 occurrences). However, this study controlled the AKs with 10+ occurrences using MeSH heading, and the resulting rankings were changed in the order of "Dental Implants" (281 occurrences), "Cone-Beam Computed Tomography" (CBCT; 266 occurrences), and "Mandible" (99 occurrences). The AKs that occurred more than 10 times were searched in the MeSH browser, and synonyms were assigned to MeSH Headings. CBCT was used through 12

different types of AKs. Researchers have used a variety of singular and plural forms and acronyms (Supplemental Material 2, http://links.lww.com/MD/E871).

Analyzing using 16 MeSH subject categories, we found that the "Analytical, Diagnostic and Therapeutic Techniques and Equipment" [E] (letter in [] represents MeSH subject category name) category had the largest distribution at 2250 AKs, representing 40.7%. This was followed by "Diseases" [C] (21.2%) and "Anatomy" [A] (14.90%). This is because "Dentistry" [E06] is a sub-categorical term in "Analytical,

Table 2

Cluster and link strength of Medical Subject Headings terms that appeared more than 10 times.

Variables	Total number of AKs	AKs > 10	MeSH terms > 10
Title	4,050	2,650	3,108
Total number of terms	15,960	4,289 (4,437)*	5,832
Number of types of AKs	7,527	199 (210)*	249 (732)
Cluster	34	9	9
Links	5,406	2,646	4,268
Total link strength	15,800	9,192	15,536

* Eleven types and 148 terms were excluded from analysis from a total of 210 types and 4,437 terms, and 199 terms were subject to network analysis.
AKs = author keywords, MeSH = Medical Subject Headings.

Diagnostic, and Therapeutic Techniques and Equipment" [E] (Supplemental Material 3, http://links.lww.com/MD/E871).

Using the advantages of the MeSH hierarchically controlled tree structure, we performed 1st stage categorization (1 digit tree number, i.e., E06), and the results were in the order of "Dentistry" [E06] (853 occurrences), "Diagnosis" [E01] (714 occurrences), "Stomatognathic Diseases" [C07] (332 occurrences), and "Musculoskeletal System" [A02] (321 occurrences) (Supplemental Material 3_1, http://links.lww.com/MD/E871)

Further specifying the 3-number hierarchy of the "Dentistry" [E06] category and expanding it to tree number 2 stage of the subcategories, we found 853 dentistry-related terms in "Dentistry" [E06]. The results were in the order of "Prosthodontics" [E06.780], including "Dental Implants", which occurred 388 times, "Orthodontics" [E06.658] occurring 104 times, "Surgery", including "Orthognathic Surgery" (88 occurrences), and "Surgery, Oral" [E06.892] occurring 100 times (Supplemental Material 4, http://links.lww.com/MD/E871). However, including the 34 cases of "Oral Surgical Procedures" [E06. 645], the occurrences totaled 134 times.

The "Diagnosis" [E01] group had the second highest distribution of AKs. In terms of sub-level terms of "Diagnostic Techniques and Procedures" [E01.370], they were in the order of CBCT (266 occurrences), "Radiography, Panoramic" (83 occurrences), "Tomography, X-Ray Computed" (76 occurrences) (Supplemental Material 5, http://links.lww.com/MD/E871).

The third was the "Stomatognathic Diseases" [C07] group, featuring 191 occurrences of "Mouth Diseases" [C07.465]

(57.5%). "Tooth Diseases" [C07.793] occurred 131 times (39.4%), "Stomatognathic System Abnormalities" (10 occurrences) represented 3.1% (Supplemental Material 6, http://links.lww.com/MD/E871).

3.3. Co-Word clustering and network analysis based on MeSH terms

This study utilized the KnowledgeMatrix Plus ver.0.80 software[8] to form 1-mode metrics and conducted a cluster analysis using VOSviewer.[9] The results indicate that the numbers of clusters for AKs and 10+ occurrences in MeSH terms were equal at 9. The results of assigning 10+ occurrence AKs (199 types, 4437 occurrences) using MeSH terms were 5,832 AKs and 249 types. These results were obtained by modifying for the errors in the AK terms with inclusion of singular/plural terms and synonyms. For the 199 types of AKs occurring more than 10 times, there were 9 clusters and 2,646 links. However, assigning the 10+ occurrence AKs to MeSH terms led to expanding 732 types of AK terms into 249 types with 9 clusters and 4,268 links (Table 2).

The clustering map of MeSH terms appearing more than 10 times is shown in Figure 3(b). When the node size is larger and closer and the link is thicker, the number of term occurrences and link strength between the terms are higher. The figure shows that CBCT, "Dental Implants", "Mandible", and "Zirconia" form key clusters and are core keywords.

Key clusters and core keywords identified and ranked with the VOS mapping technique required a similarity matrix as input and used a similarity measure known as the association strength. In each of these maps, the size of terms is determined by their "total link strength", while the thickness of each connection is based on the "link strength".[9] Furthermore, terms related to CBCT, "Dental Implants", "Mandible", and "Zirconia" are located closer to each other and have thick links, indicating that the co-occurrence potential and subject keyword relationships were high. Nine clusters marked in similar colors were created around these terms.

3.3.1. Cluster analysis. Nine clusters were formed from the network analysis of 3,108 articles assigned to 249 MeSH terms. Terms (68%) and articles (67%) were focused on the orthognathic surgery, shear bond strength, CBCT, and dental implants clusters among the 9 clusters (Table 3, Supplemental Material 7 to 15, http://links.lww.com/MD/E871).

Table 3

Cluster characteristics of 10+ occurrence Medical Subject Headings terms.

Rank of total no. of MeSH terms	Cluster name	Type of MeSH terms	Total no. MeSH terms(%)	Title(%)	Link	Total link strength	Supplemental material no.
1	Orthognathic surgery	60	1,386 (23.8)	993 (23.9)	556	1884	7
2	Shear bond strength	41	989 (17.0)	655 (15.7)	423	1758	8
3	CBCT	26	805 (13.8)	593 (14.3)	204	1060	9
4	Dental implants	27	781 (13.4)	547 (13.2)	190	1048	10
5	Bone regeneration	30	545 (9.3)	355 (8.5)	314	1116	11
6	Tooth extraction	22	429 (7.4)	325 (7.8)	124	504	12
7	Dental care	21	422 (7.2)	285 (6.9)	147	722	13
8	Tomography, X-Ray computed	18	358 (6.1)	300 (7.2)	78	260	14
9	Maxillary sinus	4	117 (2.0)	106 (2.5)	12	52	15
	Total	249	5,832 (100.0)	4,159* (100.0)	2,048	8,404	

Data shown are percentages unless otherwise specified.
CBCT = Cone-beam computed tomography, MeSH = Medical Subject Headings.
* Title is repeated based on cluster allocation of terms.

The characteristics of clusters up to rank 4 are described below.

1) Orthognathic surgery cluster network

The orthognathic surgery cluster was formed with MeSH terms (60 types, 1,386 terms), which appeared in 993 papers. Orthognathic surgery (link 28, total link strength 144) had the highest co-occurring link and link strength among terms in the orthognathic surgery cluster. "Mandible" (link 27, total link strength 94) had the highest occurrence frequency (Fig. 4(a)).

The rankings of MeSH subject categories in the orthognathic surgery cluster were "Diseases" [C] (514 occurrences), "Analytical, Diagnostic and Therapeutic Techniques and
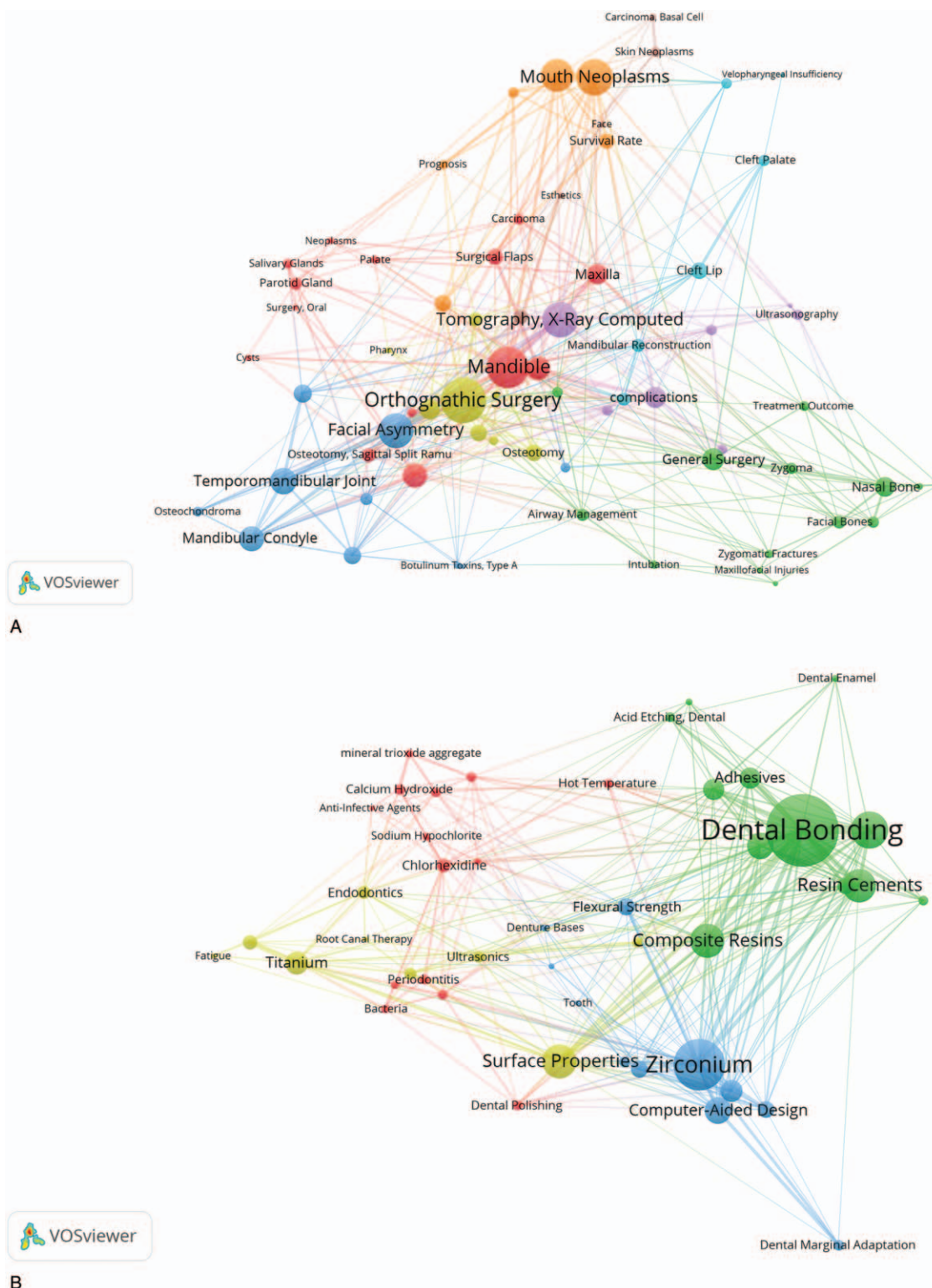

Figure 4. Clustering map and network. (a) Orthognathic surgery cluster; (b) Shear bond strength cluster.

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Table 4

Distribution of Medical Subject Headings terms in journals by 9 clusters.

Journals	Orthognathic surgery cluster	Shear bond strength cluster	CBCT cluster	Dental implants cluster	Bone regeneration cluster	Tooth extraction	Dental care cluster	Tomography, X-Ray computed cluster	Maxillary sinus cluster	Total
J Korean Assoc Oral Maxillofac Surg	334	21	108	92	91	135	31	33	33	878
Maxillofac Plast Reconstr Surg	334	9	60	60	109	60	6	24	16	678
Arch Craniofac Surg	265	5	8	4	18	28	4	28	2	362
Imaging Sci Dent	162	18	454	43	15	54	9	61	32	848
Korean J Orthod	155	86	53	23	13	4	3	151		488
J Dent Anesth Pain Med	78	5	25	10	5	17	347	6		493
J Adv Prosthodont	23	417	13	295	21	18	1	4	1	793
J Periodontal Implant Sci	23	112	43	239	233	107	4	18	30	809
Restor Dent Endod	12	316	41	15	40	6	17	33	3	483
Total	1,386	989	805	781	545	429	422	358	117	5,832

CBCT = Cone-Beam Computed Tomography.

Equipment" [E] (428 occurrences), and "Anatomy" [A] (310 occurrences).

Anatomical terms, such as "Mandible" (99 occurrences), "Temporomandibular Joint" (56 occurrences), "Surgical Flaps" (26 occurrences), "Mandibular Condyle" (26 occurrences), "Nasal Bone" (23 occurrences), "Free Tissue Flaps" (20 occurrences), and disease terms of "Facial Asymmetry" (58 occurrences), "Mandibular Fractures" (41 occurrences), "Temporomandibular Joint Disorders" (39 occurrences), "Carcinoma, and Squamous cell" (37 occurrences) were co-occurring.

And other terms, such as "Orthognathic Surgery" (88 occurrences), "Cephalometry" (30 occurrences), "Survival Rate" (30 occurrences), Magnetic Resonance Imaging" (26 occurrences), "Orthodontics" (25 occurrences), "Imaging, 3-dimensional" (23 occurrences), "Mandibular Reconstruction" (22 occurrences), and "Orbital Fractures" (32 occurrences) also co-occurred, forming 1 cluster. MeSH terms were listed in the order of total link strength in the orthognathic surgery cluster (Supplemental Material 7, http://links.lww.com/MD/E871).

The distribution of journals in the orthognathic surgery cluster was in the order of J Korean Assoc Oral Maxillofac Surg (24.1%), Maxillofac Plast Reconstr Surg (24.1%), and Arch Craniofac Surg (19.1%) (Table 4).

2) Shear bond strength cluster network

The shear bond strength cluster is a cluster formed with 41 types of MeSH terms totaling 989 terms, occurring in 655 articles. This is the term that coordinated "Dental Bonding and Shear Strength" (74 occurrences, link number 20, total link strength 124) forming "Shear Bond Strength" (74 occurrences) using the MeSH indexing method. This is the term that has high link strength with "Zirconium" (73 occurrences, 21 links, total link strength 154) and "Surface Properties" (54 occurrences, 21 links, total link strength 126) among terms in the shear bond strength cluster (Fig. 4(b)).

In terms of MeSH subject categories, they are in the order of "Chemicals and Drugs" [D] (286 occurrences), "Analytical, Diagnostic and Therapeutic Techniques and Equipment" [E] (173 occurrences), and "Phenomena and Processes" [G] (154 occurrences). The terms in "Phenomena and Processes" [G] are "Biofilms" (16 occurrences), "Color" (19 occurrences), "Flexural Strength" (37 occurrences), "Hot Temperature" (10

occurrences), "Shear Strength" (18 occurrences), and "Surface Properties" (54 occurrences) (Supplemental Material 8, http://links.lww.com/MD/E871).

Much research took place in J Adv Prosthodont and Restor Dent Endod. Printing, 3-dimensional is a Shear bond strength cluster term where research was active in 2019, with 7 articles in 2019 with 8 from J Adv Prosthodont (50%). The distribution of journals in the shear bond strength cluster was in the order of J Adv Prosthodont (42.2%), Restor Dent Endod (32.0%), and J Periodontal Implant Sci (11.3%) (Table 4).

3) CBCT cluster network

The CBCT cluster was formed with 26 types of MeSH terms comprising 805 terms, which appeared in 593 papers. CBCT is a term that occurred 266 times, with 24 total links in the clustering and a total link strength of 244. "Radiography, Panoramic" comes second. The journal, Imaging Sci Dent, comprises over 50% (Supplemental Material 9, http://links.lww.com/MD/E871).

The distribution of journals was in the order of Imaging Sci Dent (56.4%), J Korean Assoc Oral Maxillofac Surg (13.4%), and Maxillofac Plast Reconstr Surg (7.5%) (Table 4).

4) Dental implants cluster network

The dental implants cluster was formed with 27 types of MeSH terms comprising 781 terms, which appeared in 547 papers. The terms are in the order of "Dental Implants" (281 occurrences, 26 links, total link strength 316), "Osseointegration" (35 occurrences, 8 links, total link strength 72), and "Peri-implantitis" (33 occurrences, 6 links, total link strength 52), but "Dental Implants" was the core keyword with high cluster link strength and number of links (Supplemental Material 10, http://links.lww.com/MD/E871).

Eigenvector centrality[10] is also called center of gravity; the centrality of connection reflects only the number of other nodes directly connected to a specific node, whereas the eigenvector centrality reflects the importance of other connected nodes together to indicate the degree of influence of 1 node. The number of nodes directly connected to 1 node may be high if the connected node has a high degree of connection with other nodes.

In the network map of 10+ occurrence MeSH, the link and link strength of "Dental Implants" indicate that it is a term with strong links with high-frequency terms such as
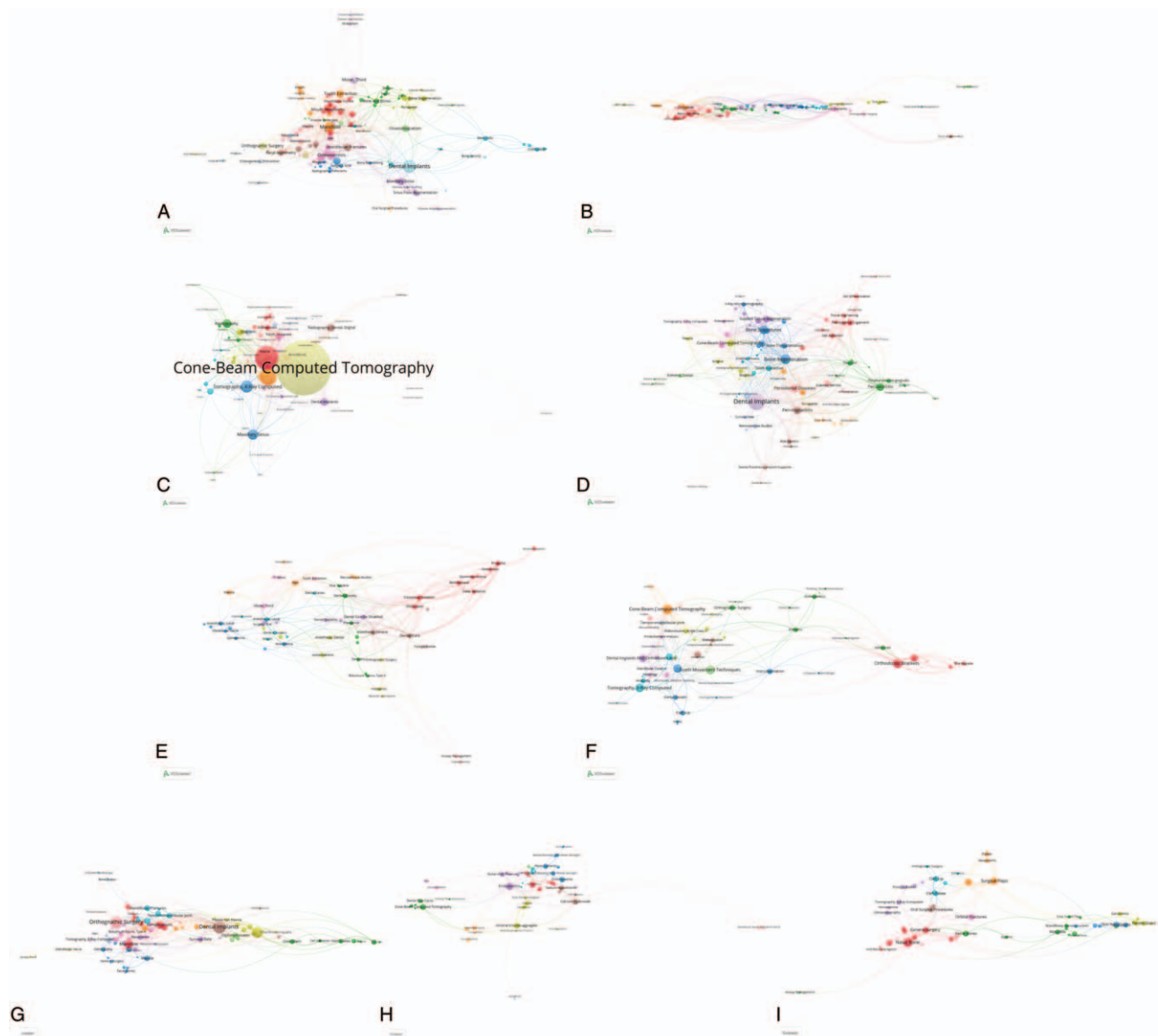
Figure 5. Dental implants eigenvector centrality in 10+ Medical Subject Headings terms network map. MeSH=Medical Subject Headings.

"Zirconium", CBCT, and "Mandible". Eigenvector centrality[10] was predicted to be high, but it was not measured in this study (Fig. 5).

The dental implants cluster, journal distribution was in the order of J Adv Prosthodont (37.8%), J Periodontal Implant Sci (30.6%), and J Korean Assoc Oral Maxillofac Surg (11.8%). J Adv Prosthodont has been continuously publishing a large number of articles since 2012, and research has increased since 2016, covering 9 journals (Fig. 6, Supplemental Material 10, http://links.lww.com/MD/E871).

The network visualization map of co-word analysis of journal cluster and rank of total link strength is as follows (Fig. 7(a) – (i)).

(a) J Korean Assoc Oral Maxillofac Surg was formed with 167 types of 878 MeSH terms (924 links, total link strength 2,272). This journal had the highest number of connections between simultaneously occurring terms. It is the journal with the most connections among co-occurring words. Link rank was the highest in "Dental Implants", followed by

"Mandible" and then "Orthognathic Surgery". MeSH term occurrence of more than 10 times in the journal occupied 38.0% of the orthognathic surgery cluster from among the 9 clusters.

(b) J Adv Prosthodont was formed with 109 types of 793 MeSH terms (619 links, total link strength 2,074). "Dental Implants" was the highest ranked, followed by "Zirconium" and then "Surface Properties". MeSH term occurrence of more than 10 times in the journal occupied 52.5% of the shear bond strength cluster from among the 9 clusters.

(c) Imaging Sci Dent was formed with 110 types of 848 MeSH terms (750 links, total link strength 2,688). CBCT was the highest ranked, followed by "Radiography, Panoramic" and then "Mandible". This journal ranked first in the CBCT cluster (53.5%).

(d) J Periodontal Implant Sci was formed with 117 types of 809 MeSH terms (904 links, total link strength 3,000). This journal ranked first in the dental implants cluster (29.5%) and bone regeneration cluster (28.8%).

Figure 6. Yearly trends of journals on "Dental implants" Medical Subject Headings terms. MeSH=Medical Subject Headings.

Figure 7. Network visualization map of co-word analysis of 9 journals clusters and total link strength.

(e) J Dent Anesth Pain Med was formed with 68 types of 493 MeSH terms (378 links, total link strength 1,280). Although "General Anesthesia" was the highest ranked, followed by "Local Anesthesia" and then "Pain", "Dental Care" had the highest total link strength at 112. This journal ranked first in the dental care cluster (70.4%).

(f) Korean J Orthod was formed with 84 types of 488 MeSH terms (378 links, total link strength 1,280). CBCT was the highest ranked, followed by "Tomography, X-Ray Computed" and then "Orthodontic Brackets". MeSH term occurrence of more than 10 times in the journal occupied 31.8% of the orthognathic surgery cluster, followed by the X-Ray computed tomography cluster (30.9%), from among the 9 clusters.

(g) Maxillofac Plast Reconstr Surg was formed with 147 types of 678 MeSH terms (624 links, total link strength 1,552). "Dental Implants" was the highest ranked, followed by

"Orthognathic Surgery" and then "Bone Regeneration". MeSH term occurrence of more than 10 times in the journal occupied 49.3% of the orthognathic surgery cluster from among the 9 clusters.

(h) Restor Dent Endod was formed with 108 types of 483 MeSH terms (326 links, total link strength 892). "Endodontics" was the highest ranked, followed by "Composite Resins" and then "Calcium Hydroxide". MeSH term occurrence of more than 10 times in the journal occupied 65.42% of the shear bond strength cluster from among the 9 clusters.

(i) Arch Craniofac Surg was formed with 85 types of 362 MeSH terms (250 links, total link strength 632). "Nasal Bone" was the highest ranked, followed by "Surgical Flaps", "Facial Bones", and then "Reconstructive Surgical Procedures". MeSH term occurrence of more than 10 times in the journal occupied 73.2% of the orthognathic surgery cluster from among the 9 clusters.

Medical Subject Headings terms in order of total link strength.

Variable	2010–2014 [Period 1]	2015–2019 [Period 2]	Total MeSH terms > 10
Title	1,493	1,615	3,108
Total number of MeSH terms	2,736	3,096	5,832
Number of types of terms	247	249	249 (732)
Cluster	14	11	9
Links	2,262	2,840	4,268
Total link strength	6,996	8,540	15,536

MeSH = Medical Subject Headings.

3.3.2. Time series analysis. To identify research trends in different periods, we grouped 2010 to 2014 into o1 period (Period 1) and 2015 to 2019 into another (Period 2). There were differences in the number of resulting clusters. Although total number of MeSH terms was small in Period 1, the number of clusters was larger than in Period 2 (Table 5).

In the Period 1 density map, "Odontogenesis" terms were used as co-occurring terms. Although "Odontogenesis" terms were published in 2019 as a 3-part study, no links were found (Fig. 8 (a)). In the Period 2 density map, "Printing and 3-dimensional" is term that appeared and are connected to "Tomography, X-Ray Computed", "Computer-Aided Design", "Durapatite", "Dental Bonding and Shear Strength". Terms for orthopedic surgery and dental care are core terms compared to Period 1 (Fig. 8(b)).

The term "Odontogenesis" was a co-occurring term in Period 1 and then was published in 3 articles in 2019; however, it does not have a link. The terms "Dentistry", "Tooth root", "Botulinum toxins, Type", "Epinephrine", "Rhinoplasty", and "Hemangioma" did not have links in Period 1 but saw links form in Period 2. The term with a newly formed link after 2015 was Skin neoplasms in Arch Craniofac Surg, which saw active research.

The term "Printing, 3-dimensional" appeared in Period 2 and had strong links with CBCT, "Computer-Aided Design", "Durapatite", "Dental Bonding and Shear Strength". 3D technology was actively studied in 2019. Eight of the 7 articles published in 2019 were in J Adv Prosthodont (50%) (Supplemental Material 16, http://links.lww.com/MD/E871).

4. Discussion

Researchers select targeted journals for submission by using metrics recommended by databases, such as JCR or SJR, and relying on peer experience. However, WoS, and SJR cover too wide a range of subject areas. Because most articles written by researchers are about specific and detailed topics in their subject field, for the purpose of selecting a target journal to determine submission, more specific subject areas are needed. This study aims to aid researchers in selecting an optimum journal to submit a study.

The ones most closely related to our research methods are Liu et al[11] and Dehdarirad et al,[12] but the study of Liu et al[11] did not involve assigning MeSH terms. Only Tooth injuries was searched as the MeSH within PubMed. Also, Dehdarirad et al[12]'s term map was based on MeSH in VOSviewer's built-in function. Most studies have visualized with VOSviewer after using MeSH in search strategies or matching with text words.[12–21] For example, Gan et al[13] and Hernandez-Vasquez et al[14] did use text words to search and extract MeSH terms for co-word

analysis. Mazaheri et al[16] did not involve AKs assigned by MeSH but investigated AKs matching or not matching with index term categories. Unless they specifically searched for a particular topic, research findings published in such non-dental journals may not be readily accessible to the dental community.[17] Therefore, as their singular/plural forms and acronyms might lead to problems, corpora were formed using search strategies around particular keywords or limiting journal groups.[18] Sometimes, singular/plural forms and acronyms were reviewed manually to be reflected.[19]

This study categorized MeSH entry terms to control vocabulary for AKs and assigned MeSH terms based on the indexing principles of NLM. By classifying AKs as MeSH, it was possible to grasp the appearance of MeSH tree structures in terms of specific subject areas in all medical fields.

This study categorized the subject areas of 9 journals in dentistry using MeSH structures. Analyzing 16 MeSH subject categories, this study found that the "Analytical, Diagnostic, and Therapeutic Techniques and Equipment" [E] category had the largest distribution at 2250 AKs, representing 40.7%. This was followed by "Diseases" [C] (21.2%) and "Anatomy" [A] (14.90%). This study further specified the MeSH tree number hierarchy of "Dentistry" [E06] and analyzed it using tree number 2 stage and found that there were 853 dentistry-related terms that were concentrated in "Dentistry" [E06].

It is important to implement a preprocessing step for the terms using a controlled vocabulary list, such as MeSH, which present the themes of articles as a set of normalized words.[11] This study processed and analyzed vocabulary using MeSH headings and was significant in that it secured the reliability of data by controlling concepts that were expressed in various AKs.

As a result of this study, a core study area in dentistry over the past 10 years was found to be facial asymmetry, which is a topic under oral surgery and medicine. And orthognathic surgery focused on mandibular fractures. The second core area was shear bond strength of zirconia, an area of dentistry. This study analyzed the articles during the past 5 years by classifying them into 3 chronological categories and found that studies on 3D printing technologies were increasing recently, and studies on CBCT-focused diagnostic imaging technologies and their performance were increasing since 2010.

The analysis software we used was VOSviewer, and there were few bibliometric studies that utilize this software and AKs assigned by MeSH. Grouping total terms into several groups using the distance between terms and similarity allowed for characteristics between groups to be identified, which then helped to understand the structure of the overall article. When the cluster was analyzed and visualized with the AKs on the journals to be submitted, the target journal related to the researcher's major topics was discovered.

"Orthognathic Surgery" had the highest concurrent link and link strength among orthognathic surgery cluster terms, and "Mandible" had the most occurrences. Journals publishing the subject areas included in the orthognathic surgery cluster were in the order of J Korean Assoc Oral Maxillofac Surg, Maxillofac Plast Reconstr Surg, and Arch Craniofac Surg. The shear bond strength cluster was formed with 41 types of MeSH terms comprising 989 terms, which appeared in 655 articles. Zirconium was a term that appeared 154 times, with 28 links and 73 total link strength, forming the core of the Shear bond strength cluster. More than 50% of the research for this area is published in J Adv Prosthodont and Restor Dent Endod.
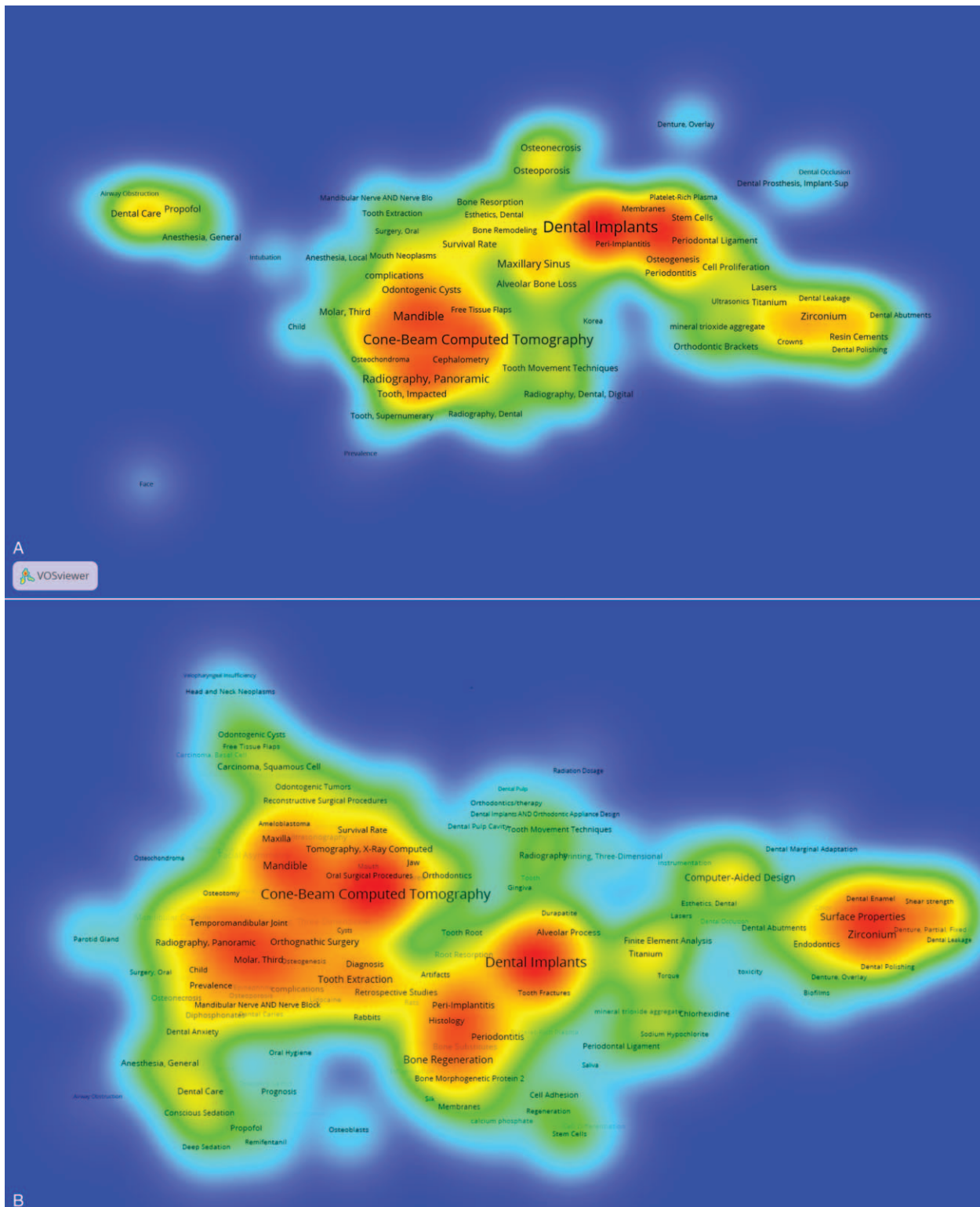
Figure 8. Density visualization map of co-word analysis of 2 periods: (a) Period 1 (2010–2014) and (b) Period 2 (2015–2019).

The dental implants area is a sub-domain that has been at the very core in the past 10 years with 281 occurrences; this sector had a high eigenvector centrality with strong links to high-occurrence words, such as CBCT and "Mandible". Peri-

implant tissue healing and health was the predominant research subject. High-impact terms were related to implant success, survival, failure, and peri-implantitis. Furthermore, Yeung et al[22] predicted that the biologic complication that

accompanies dental implants, namely, peri-implantitis, should also have received high attention. The distribution of journals was in the order of J Adv Prosthodont (37.8%), J Periodontal Implant Sci (30.6%), and J Korean Assoc Oral Maxillofac Surg (11.8%) (Table 4). If researchers are going to submit a paper on peri-implant diseases, they may consider the above journals.

According to a study of top cited articles in implant dentistry using WoS, the majority of them were published in Clinical Oral Implants Research, International Journal of Oral & Maxillofacial Implants, Journal of Clinical Periodontology, and Journal of Periodontology.[23] In this study, the cited articles were not analyzed.

The 9 journals included 3 SCIE journals, 7 Scopus journals, and 3 PMC journals among Korean dental journals. It is possible to search for the subject area "Dentistry, oral surgery & medicine" in WoS; the range of subject areas in WoS is too broad. On the other hand, the Scopus & SJR databases further classifies the main subject area of dentistry into "General dentistry", "Dentistry (miscellaneous)", "Dental assisting", "Dental hygiene", "Oral surgery", "Orthodontics", and "Periodontics" for searching.[24] SJR is a database that researchers often refer to when submitting to journals. In the bibliographic databases, filters are provided with all of the subject areas under a single main subject because researchers expect search results to be complete without any missing articles. Furthermore, a unique subject area that is differentiated from other journals is a key criterion for a journal to be registered with a bibliographic database.

Kim et al[25] analyzed that there were many flaws in Scopus' classification system. For example, the oral surgery category comprises 59 titles, but many of these may not actually be classified as oral surgery titles. The category of dental implantology comprises multidisciplinary fields, and it should be classified separately.[23] Researchers should identify the optimal journals to submit to based on their research. If researchers only choose journals with high JIFs to publish their manuscripts, their submissions may fail.

The analysis of clusters in a title can grasp the overall trend, but such clusters are too large for targeting specifically. The title terms of J Adv Prosthodont, Korean J Orthod, and J Korean Assoc Oral Maxillofac Surg formed different clusters from other journals. J Periodontal Implant Sci is composed of terms that are commonly used in each journal, and it is highly likely to be a core journal because each journal is closely related. As a result of network analysis of the code word analysis and total link strength of 9 journal clusters, it is possible to check detailed self-subject areas, so it is recommended that researchers refer to them when submitting journals.

In the future, cluster analysis using AKs and MeSH may be a good analytic method for researchers who want to know what research areas are trending upward and how to identify the optimal journals for submission based on their study. When selecting a target journal to determine submission, a much more specific subject categories is needed on a journal-by-journal basis. This is because most articles apply to a specific subject in a detailed subject field. As researched in this study, a keyword cluster analysis of approximately 5 to 10 years is recommended. Also, be sure to review the journal's aims and scope.

Author contributions

JSN and JJN designed the study, performed the search, assigned Medical Subject Headings (MeSH), analyzed the data, and wrote the paper.

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