

## REVIEW

## Research focuses and trends in third molar: A bibliometric analysis

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## Abstract

**Aim:** The authors conducted a bibliometric analysis to quantitatively assess the current research trend, performance and focus over the last 30 years in third molars surgery.

**Materials and Method:** The data used in this study comes from the Clarivate Analytics Web of Science Core Collection, the online version of the Science Citation Index Expanded (SCI-EXPANDED) (data updated on 22 March 2022). The extraction was conducted according to TOPIC (title, abstract, author keywords and *KeyWords Plus*) from 1991 to 2020.

**Results:** During a period of 30 years, a total of 6569 publications were found within 15 document types published in SCI-EXPANDED. Article types (88%) were published mostly frequently and had the most citations per publication, followed by review articles (3.9%). The top three publication countries were the USA, Brazil and the UK. Forty-four percent of the articles were inter-institutionally collaborative articles. Twenty percent of the articles were internationally collaborative articles. The most productive institutes over the past three decades have been the University of São Paulo (Brazil), followed by the University of Campinas (Brazil) and the University of North Carolina (USA). Keywords can be considered very helpful in article dissemination.

**Conclusion:** The present bibliometric analysis showed that articles published by international collaborative authors had the highest citations and there was no association between the number of citations and the quality of published articles on third molars. Identifying future research directions based on a bibliometric analysis of the characteristics of available literature in a field reduces the error margin and thus improves decision-making.

## KEYWORDS

bibliometric, citations, Scientometrics, SCI-EXPANDED, third molar surgery, web of science

## INTRODUCTION

Third molar surgery is the surgical procedure most commonly performed by oral and maxillofacial surgeons.<sup>1</sup> The most common postoperative sequelae are pain, swelling, bruising, trismus, infection and hematoma.<sup>2</sup> Recent advances have been applied to minimize the incidence of postoperative complications after third molars surgery, including ozone therapy,<sup>3</sup> cryotherapy,<sup>4,5</sup> platelet-rich plasma,<sup>6,7</sup> platelet-rich fibrin,<sup>6</sup> piezoelectric surgery<sup>8</sup> and lasers.<sup>9</sup>

Bibliometric analyses were found to identify the impact of publications and research groups in their area. Additionally, it is also the best method to quantify the quality of published papers for organizations, authors and countries.<sup>10</sup> Bibliometrics makes it simple to study and decode variety

developments on a topic to track the dynamics and evolution of scientific knowledge. Identifying future research directions based on a bibliometric analysis of the characteristics of available literature in a subject reduces the error margin and thus improves decision-making. Although there have been a large number of bibliometrics, very few are associated with third molars surgery. Thus, the authors of the present study aimed to perform bibliometric study on research foci and trends in the third molar.

## METHODS

The data used in this study comes from the Clarivate Analytics Web of Science Core Collection (WoS), the online version

of the Science Citation Index Expanded (SCI-EXPANDED) (data updated on March 22, 2022). Extraction was done by TOPIC (title, abstract, author keywords and *KeyWords Plus*) from 1991 to 2020. The database was searched using the keywords: “third molar”, “third molars”, “wisdom tooth” and “wisdom teeth”. Quotation marks (“”) and Boolean operator “or” were used, which ensured the appearance of at least one search keyword in the terms of TOPIC including title, abstract, author keywords and *KeyWords Plus*. A total of 6569 documents from 1991 to 2020 were searched out in SCI-EXPANDED. *KeyWords Plus* provides additional search terms extracted from the titles of articles cited by authors in their bibliographies and footnotes in the Institute of Science Information (ISI) (now Clarivate Analytics) database, expanding the title-word and author-keyword indexing.<sup>11</sup> It has been pointed out that documents only searched out by *KeyWords Plus* are irrelevant to the search topic.<sup>12</sup> Ho's group firstly proposed the ‘front page’ filter, which includes the title, abstract and author keywords.<sup>13,14</sup> This filter could prevent unrelated publications from being introduced for analysis.<sup>13</sup>

The full record in SCI-EXPANDED and the number of citations in each year for each document were downloaded and checked into Excel Microsoft 365, and additional coding was performed manually.<sup>15,16</sup> Finally, 6569 documents that contained search keywords on their ‘front page’ were defined as third molar research publications. The Journal Impact Factors (IF<sub>2020</sub>) were taken from the Journal Citation Reports (JCR) published in 2020. More details about how bibliometric analysis was performed presented in (Data S1).

Some graphic illustrations were created using the free software VOSviewer (Leiden University, The Netherlands) with authorship and keywords from WoS to provide a visual form of bibliometric analysis.

## RESULTS AND DISCUSSION

### Characteristics of document types

A study conducted by Ho's group identified the characteristics of document types based on citations per publication (CPP<sub>year</sub>) and number of authors per publication (APP).<sup>17</sup> A total of 6569 third molar documents published in SCI-EXPANDED were found among 13 document types listed in Table 1. The use of TC<sub>2020</sub> and CPP<sub>2020</sub> was found to be advantageous due to their invariability and ensured repeatability compared to the number of citations from the WoS. The study analysed 6569 documents on third molars, of which 88% were articles with an APP of 4.8. The percentage of articles on third molars was higher than medical-related topics except for fracture non-unions. Proceedings papers had the highest CPP<sub>2020</sub> value of 27. Articles were selected for further analysis, and 99% were in English. Non-English articles had fewer citations, with a CPP<sub>2020</sub> of 5.5, while English articles had a CPP<sub>2020</sub> of 22. The CPP<sub>2020</sub> of third molars publications rose sharply, attaining a plateau at 11 years of publication and then declining. The study concludes that assessing the impact of publications reasonably requires citations accumulated for at least one decade (Figure 1).

### WoS category and journals

According to the study, a total of 695 journals have published articles related to third molar in 113 WoS categories in SCI-EXPANDED, with the top 10 most productive categories mainly in Dentistry, Oral Surgery and Medicine. Therefore, the cumulative percentage of categories in Table 2 exceeds 100%. The article also highlights that the International Journal of Oral and Maxillofacial Surgery was classified

TABLE 1 Citations and authors according to the document type.

Document type	TP	%	TP*	AU	APP	TC <sub>2020</sub>	CPP <sub>2020</sub>
Article	5775	88	5774	27,579	4.8	124,411	22
Review	254	3.9	254	1107	4.4	4160	16
Letter	201	3.1	200	466	2.3	294	1.5
Meeting abstract	164	2.5	164	609	3.7	8	0.049
Editorial material	123	1.9	121	252	2.1	367	3.0
Proceedings paper	90	1.4	90	401	4.5	2464	27
Correction	23	0.35	23	83	3.6	11	0.48
Note	16	0.24	16	42	2.6	175	11
News item	8	0.12	4	4	1.0	10	1.3
Retraction	4	0.061	4	16	4.0	0	0
Book chapter	1	0.015	1	9	9.0	4	4
Retracted publication	1	0.015	1	3	3.0	6	6.0
Addition correction	1	0.015	1	3	3.0	0	0

Note: TP: number of publications; TP\*: number of publications with author information; AU: number of authors; APP: number of authors per publication; TC<sub>2020</sub>: the total number of citations from Web of Science Core Collection since publication year to the end of 2020; CPP<sub>2020</sub>: number of citations (TC<sub>2020</sub>) per publication (TP); N/A: not available.

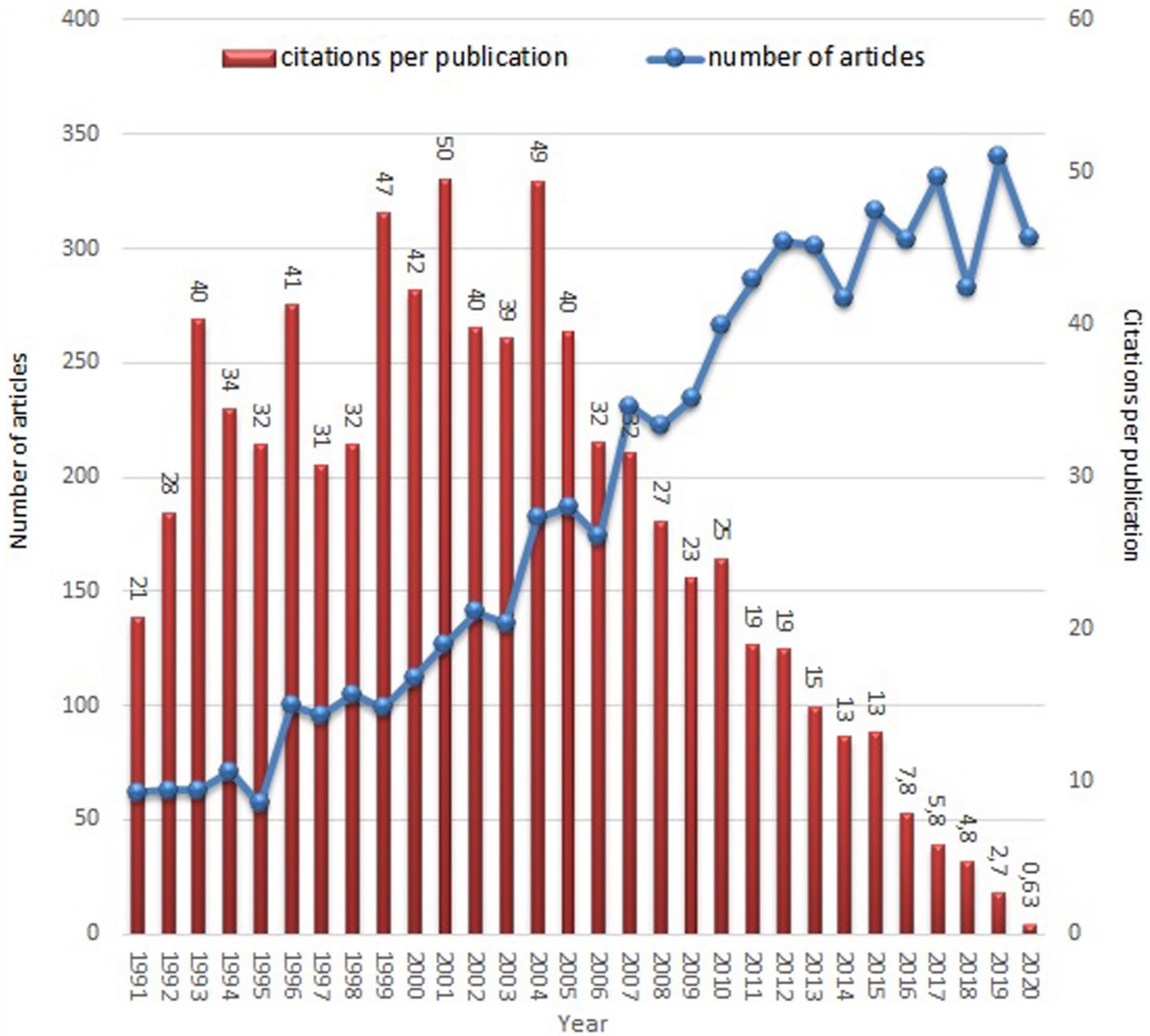


FIGURE 1 Number of third molar articles and citations per publication by year.

TABLE 2 The top 10 most productive Web of Science categories.

Web of science category	No. journals	TP (%)	APP	CPP <sub>2020</sub>
Dentistry, oral surgery and medicine	92	3797 (66)	4.6	23
Surgery	212	657 (11)	4.4	17
Legal medicine	17	226 (3.9)	5.1	21
Biomaterials materials science	41	223 (3.9)	5.6	39
General and internal medicine	169	197 (3.4)	4.6	17
Biomedical engineering	90	186 (3.2)	5.4	27
Pharmacology and pharmacy	276	149 (2.6)	5.8	24
Anatomy and morphology	21	124 (2.1)	4.4	10
Research and experimental medicine	140	124 (2.1)	5.7	13
Radiology, nuclear medicine and medical imaging	134	109 (1.9)	4.7	14

Note: TP: total number of articles; %: percentage of articles in all third molar articles; APP: number of authors per paper; CPP<sub>2020</sub> citations per paper (TC<sub>2020</sub>/TP).

in categories of Dentistry, Oral Surgery and Medicine and Surgery. The Journal of Oral and Maxillofacial Surgery published the most articles related to third molars, while Dental Materials had the highest CPP<sub>2020</sub> of 49. Overall, the study provides valuable insights into the productivity and trends related to third molars in scientific journals.

Compare the top 13 productive journals, third molar articles published in *Dental Materials* (IF<sub>2020</sub> = 5.304) had the highest CPP<sub>2020</sub> of 49 while articles in *Medicina Oral Patologia Oral Y Cirugia Bucal* (IF<sub>2020</sub> = 2.047) had only 12. The APP ranged from 3.3 in *British Dental Journal* to 5.4 in both of *Journal of Endodontics* and *Dental Materials*, respectively. *Oral Surgery Oral Medicine Oral Pathology Oral Radiology and Endodontology* was no longer classified in SCI-EXPANDED after 2011. The journal with the highest IF<sub>2020</sub> of 79.321 was *Lancet* with two articles followed by *Nature Medicine* with one article (IF<sub>2020</sub> = 53.440) and *Nature* with two articles (IF<sub>2020</sub> = 49.962).

### Publication performances: Countries and institutions

The study found that the first and corresponding authors are the most significant contributors to research articles, and the corresponding author's institution is often the home base of the study.<sup>18</sup> The article also highlights the international collaboration and citation practices among authors from various countries.<sup>10</sup> A total of 5766 articles were published by affiliated authors from 104 countries including 4620 single-country articles (80% of 5766 articles) published by authors from 75 countries with a CPP<sub>2020</sub> of 20 and 1146 international collaborative articles (20%), published by authors from 97 countries with a CPP<sub>2020</sub> of 28. The USA emerged as the top country in publishing third molar articles, followed by Brazil, UK and Turkey. Table 3 shows the top 10 most productive countries. The USA not only had the greatest CPP<sub>2020</sub> of 34 but also dominated the six publication

indicators with a TP of 1246 articles (22% of 5766 articles), an IP of 747 articles (16% of 4620 single-country articles), a CP of 499 articles (44% of 1146 internationally collaborative articles), an FP of 961 articles (17% of 5766 first-author articles), an RP of 932 articles (16% of 5673 corresponding-author articles) and an SP of 65 articles (32% of 206 single-author articles). Development trends in the publication of the top four productive countries are presented in Figure 2.

Concerning institutions, 2219 third molar articles (38% of 5766 articles) were from single institutions with a CPP<sub>2020</sub> of 21 while 3547 articles (62%) were institutional collaborations with a CPP<sub>2020</sub> of 22. The 10 most productive institutions and their characteristics are presented in Table 4. Three of the top 10 most productive institutions are located in the USA, two in Brazil and one each in China, Finland, Turkey, Japan and Spain.

The use of specific metrics such as CPP<sub>2020</sub>, TP, IP, CP, FP, RP and SP provides a comprehensive understanding of the publication patterns of authors and institutions. The study also highlights the top 10 most productive institutions in the field, with the University of Sao Paulo in Brazil ranking first in terms of TP, IP, CP, FP and RP. The information presented in the article provides valuable insights into the research patterns of third molar studies and highlights the importance of collaboration and international citation practices. The article is useful for researchers, policymakers and institutions interested in understanding the trends and patterns in third molar research.

### Publication performances: Authors

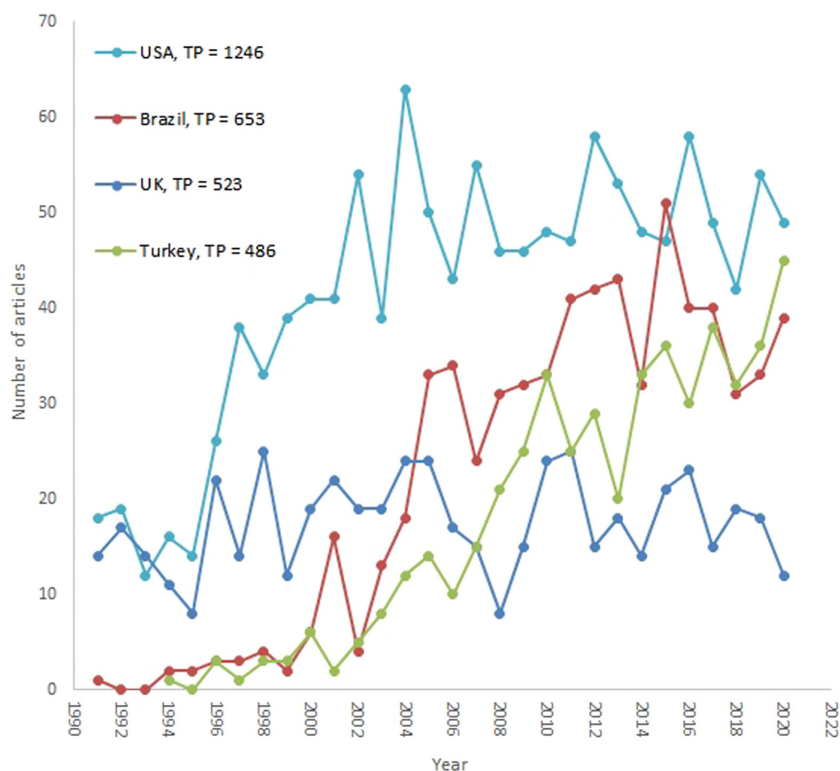
This article presents an analysis of authorship patterns in third molar research, with a focus on the number of authors per article, the most prolific authors and publication characteristics. The average number of authors per article was 4.8, with a maximum of 44 authors in one article. The majority of articles were written by groups of 2–6 authors. Table 5

TABLE 3 Top 10 most productive countries.

Country	TP	TPR (%)	IPR (%)	CPR (%)	FPR (%)	RPR (%)	SPR (%)	CPP <sub>2020</sub>
USA	1246	1 (22)	1 (16)	1 (44)	1 (17)	1 (16)	1 (32)	34
Brazil	653	2 (11)	2 (10)	2 (17)	2 (10)	2 (10)	12 (1.5)	20
UK	523	3 (9.1)	4 (7.6)	4 (15)	4 (7.2)	4 (7.2)	2 (14)	26
Turkey	486	4 (8.4)	3 (9.2)	13 (5.4)	3 (7.9)	3 (8.0)	3 (5.8)	13
Japan	423	5 (7.3)	5 (6.3)	5 (11)	5 (6.0)	5 (6.1)	4 (4.4)	25
Germany	413	6 (7.2)	7 (5.1)	3 (16)	7 (5.6)	7 (5.6)	6 (3.9)	26
China	403	7 (7.0)	6 (6.0)	6 (11)	6 (5.8)	6 (5.9)	11 (1.9)	19
Italy	315	8 (5.5)	8 (4.4)	7 (10)	8 (4.4)	8 (4.5)	20 (1.0)	21
Spain	253	9 (4.4)	9 (3.7)	9 (7.0)	9 (3.7)	9 (3.7)	N/A	22
South Korea	157	10 (2.7)	10 (2.4)	15 (4.2)	10 (2.3)	10 (2.4)	24 (0.49)	29

Note: TP: total number of articles; TPR (%): rank and the percentage of total articles; IPR (%): rank and percentage of single-country articles in all single-country articles; CPR (%): rank and percentage of internationally collaborative articles in all internationally collaborative articles; FPR (%), rank and the percentage of first-author articles in all first-author articles; RPR (%), rank and the percentage of the corresponding-author articles in all corresponding-author articles; SPR (%), rank and the percentage of the single-author articles in all single-author articles; CPP<sub>2020</sub> citations per paper (TC<sub>2020</sub>/TP); N/A: not available.

**FIGURE 2** Developments of the top four productive countries.



**TABLE 4** Top 10 most productive institutions.

Country	TP	TPR (%)	IPR (%)	CPR (%)	FPR (%)	RPR (%)	SPR (%)	CPP <sub>2020</sub>
University of Sao Paulo, Brazil	225	1 (3.9)	1 (2.4)	1 (4.8)	1 (1.9)	1 (1.9)	21 (0.49)	25
University of Estadual Campinas, Brazil	118	2 (2.0)	7 (0.90)	2 (2.8)	3 (1.0)	3 (1.1)	N/A	24
University of North Carolina, USA	100	3 (1.7)	2 (2.1)	7 (1.5)	2 (1.4)	2 (1.4)	2 (1.5)	35
University of Hong Kong, China	94	4 (1.6)	4 (1.1)	4 (1.9)	5 (0.85)	5 (0.83)	10 (1.0)	37
University of Helsinki, Finland	86	5 (1.5)	7 (0.90)	5 (1.9)	4 (0.92)	4 (0.86)	2 (1.5)	32
Med Coll Georgia, USA	84	6 (1.5)	87 (0.23)	3 (2.2)	7 (0.66)	9 (0.60)	N/A	68
Tokyo Medical and Dental University, Japan	70	7 (1.2)	12 (0.77)	9 (1.5)	8 (0.64)	6 (0.63)	21 (0.49)	44
Harvard University, USA	66	8 (1.1)	68 (0.27)	6 (1.7)	38 (0.29)	53 (0.25)	21 (0.49)	52
Istanbul University, Turkey	66	8 (1.1)	9 (0.86)	10 (1.3)	9 (0.62)	7 (0.62)	N/A	12
University of Barcelona, Spain	65	10 (1.1)	28 (0.5)	7 (1.5)	16 (0.49)	16 (0.48)	N/A	20

Note: TP: total number of articles; TPR (%): rank and the percentage of total articles; IPR (%): rank and percentage of single-institute articles in all single-institute articles; CPR (%): rank and percentage of internationally collaborative articles in all internationally collaborative articles; FPR (%): rank and the percentage of first-author articles in all first-author articles; RPR (%): rank and the percentage of the corresponding-author articles in all corresponding-author articles; SPR (%), rank and the percentage of the single-author articles in all single-author articles; CPP<sub>2020</sub> citations per paper (TC<sub>2020</sub>/TP); N/A: not available.

lists the 19 most prolific authors with 28 articles or more. R.P. White was the most productive author with 67 articles (Table 1), while I. Venta had the most first-author articles with 20. D.H. Pashley had the highest CPP<sub>2020</sub> of 74. The Y-index was used to analyse the publication potential and characteristics of the leading 27 potential authors in third molar research

(Figure 3). Different families of author publication potential or publication characteristics were represented by the location on the graph along one of the curves or along a line from the origin, respectively. There was a potential for bias in authorship analysis due to different authors sharing the same name or the same author using different names over time.<sup>19</sup>

TABLE 5 Top 19 most productive authors with 28 articles or more.

Author	R (TP)	TP CPP <sub>2020</sub>	R (FP)	FP CPP <sub>2020</sub>	R (RP)	RP CPP <sub>2020</sub>	R (SP)	SP CPP <sub>2020</sub>	<i>h</i>	<i>R</i> ( <i>j</i> )
R.P. White	1 (67)	23	12 (9)	26	1 (60)	26	4 (2)	6.0	1.422	1 (69)
D.H. Pashley	2 (66)	74	18 (8)	53	4 (22)	17	N/A	N/A	1.222	4 (30)
C. Gay-Escoda	3 (53)	22	300 (2)	10	4 (22)	22	N/A	N/A	1.480	6 (24)
F.R. Tay	4 (52)	66	24 (7)	107	11 (13)	11	N/A	N/A	1.138	17 (19)
R.M. Carvalho	5 (43)	60	35 (6)	84	43 (7)	30	N/A	N/A	0.8622	36 (13)
C. Phillips	5 (43)	27	49 (5)	27	198 (3)	11	N/A	N/A	0.5404	85 (8)
M. Giannini	7 (39)	25	792 (1)	147	4 (22)	17	N/A	N/A	1.525	7 (23)
A. Wenzel	7 (39)	20	12 (9)	31	31 (9)	29	19 (1)	7.0	0.7854	20 (18)
A.D. Loguercio	9 (36)	35	70 (4)	48	22 (10)	27	N/A	N/A	1.190	29 (14)
J. Tagami	9 (36)	40	N/A	N/A	N/A	N/A	N/A	N/A	0	5378 (0)
T.B. Dodson	11 (35)	38	49 (5)	15	9 (15)	14	2 (4)	17	1.249	14 (20)
S. Offenbacher	12 (34)	23	792 (1)	12	861 (1)	93	N/A	N/A	0.7854	886 (2)
E. Valmaseda-Castellon	13 (33)	21	300 (2)	122	43 (7)	56	N/A	N/A	1.292	73 (9)
A. Reis	14 (32)	40	24 (7)	42	16 (11)	52	N/A	N/A	1.004	20 (18)
R. Cameriere	15 (31)	18	49 (5)	35	198 (3)	44	N/A	N/A	0.5404	85 (8)
Y. Wang	15 (31)	35	12 (9)	42	11 (13)	35	N/A	N/A	0.9653	8 (22)
A. Schmeling	17 (28)	31	792 (1)	2.0	7 (18)	19	N/A	N/A	1.515	17 (19)
M. Toledano	17 (28)	34	4 (11)	42	8 (17)	8.1	N/A	N/A	0.9965	5 (28)
I. Venta	17 (28)	18	1 (20)	20	3 (23)	18	4 (2)	21	0.8551	2 (43)

Note: TP: total number of articles; FP: number of first-author articles; RP: number of corresponding-author articles; R: rank; *h*: Y-index constant, publication characteristics; *j*: Y-index constant, publication potential; CPP<sub>2020</sub> citations per paper (TC<sub>2020</sub>/TP); N/A: not available.

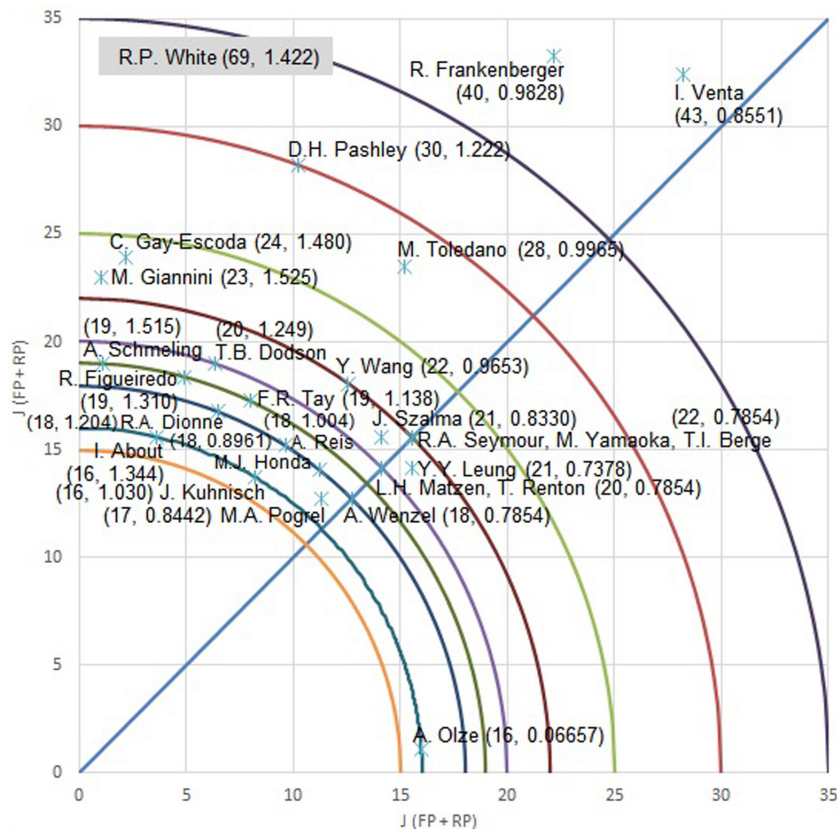


FIGURE 3 Top 27 authors with Y-index ( $j \geq 16$ ).

## Citation histories of the 10 most frequently cited articles

It was recommended that search keywords in article title or author keywords have more focus on a bibliometric study topic.<sup>20</sup> In the top 40 articles with a TC<sub>2020</sub> of 194 or more, article “Isolation of precursor cells (PCs) from human dental follicle of wisdom teeth”<sup>21</sup> was the only article contain search keywords in its title.<sup>21</sup> Similarly, in the top 225 articles with a TC<sub>2020</sub> of 84 or more, article “Forensic age estimation in living subjects: The ethnic factor in wisdom tooth mineralization”<sup>22</sup> was the only article contain search keywords in its author keywords.<sup>22</sup> Table 6 shows the top 10 most frequently cited articles with search keywords in their title or author keywords.<sup>21–30</sup>

Two of the ten articles were published in the *Journal of Oral and Maxillofacial Surgery* (IF<sub>2020</sub> = 1.895) (Table 7). Eight of the 10 articles were single-country articles, while three of the 10 articles were multiple-country articles. The USA, Spain, Japan, UK, Canada, Belgium and Jordan each published one of top 10 most frequently cited articles.

Citations of an article are not always high.<sup>31</sup> It is necessary to understand the citation history of a highly cited

article. The article by ‘Morsczeck et al. (2005)’ had the highest number of citations in 2020 equal to 512, published in *Matrix Biology* (IF<sub>2020</sub> = 11.583). This article had the most citations in 2015.<sup>21</sup> This article was published by seven authors from Germany and Switzerland. In this study, the authors isolated progenitor cells or precursor cells derived from dental follicle of human third molars and the authors found that cultured precursor cells are unique undifferentiated lineage committed cells residing in the periodontium prior or during tooth eruption. The retrospective cohort published by Bui et al., had no citations in the year of publication. Therefore, the citations increased gradually to reach the peak in 2014.<sup>23</sup> Six of the top 10 most frequently cited articles discussed an incidence of and risk factors of postoperative complications following third molars surgery.<sup>23–25,27,28,30</sup> Specifically, four articles talked about inferior alveolar nerve injury following third molars surgery.<sup>23,27,28,30</sup>

Two articles were radiological assessment for estimation of living age.<sup>22,29</sup> Concerning study design of the top 10 most frequently cited articles, only one article was randomized clinical study,<sup>27</sup> six studies a non-randomized perspective studies,<sup>24–26,28–30</sup> two retrospective studies<sup>22,23</sup> and one study ex in vivo.<sup>21</sup>

TABLE 6 The top 10 most frequently cited articles with search keywords in their title or author keywords.

Rank (TC <sub>2020</sub> )	Rank (C <sub>2020</sub> )	Title	Country	Reference
5 (515)	5 (43)	Isolation of precursor cells (PCs) from human dental follicle of wisdom teeth	Germany, Switzerland	Morsczeck et al. <sup>21</sup>
41 (193)	18 (24)	Types, frequencies and risk factors for complications after third molar extraction	USA	Bui et al. <sup>23</sup>
51 (172)	34 (18)	Inferior alveolar nerve damage after lower third molar surgical extraction: A prospective study of 1117 surgical extractions	Spain	Valmaseda-Castellón et al. <sup>24</sup>
55 (158)	64 (13)	A comparative study of cone-beam computed tomography and conventional panoramic radiography in assessing the topographic relationship between the mandibular canal and impacted third molars	Japan	Tantanapornkul et al. <sup>25</sup>
60 (149)	40 (16)	Forensic age estimation in living subjects: The ethnic factor in wisdom tooth mineralization	Germany, Japan, South Africa	Olze et al. <sup>26</sup>
62 (147)	48 (15)	A randomized controlled clinical trial to compare the incidence of injury to the inferior alveolar nerve as a result of coronectomy and removal of mandibular third molars	UK	Renton et al. <sup>27</sup>
79 (131)	36 (17)	Extraction of impacted mandibular third molars: Postoperative complications and their risk factors	Canada	Blondeau and Daniel <sup>28</sup>
85 (128)	226 (8)	Third molar root development in relation to chronological age: a large sample sized retrospective study	Belgium	Gunst et al. <sup>29</sup>
96 (118)	56 (14)	Sensory nerve impairment following mandibular third molar surgery	Jordan	Bataineh <sup>30</sup>
96 (118)	161 (9)	Validation of common classification systems for assessing the mineralization of third molars	Germany	Olze et al. <sup>22</sup>

Note: TC<sub>2020</sub>: the total number of citations from Web of Science Core Collection since publication year to the end of 2020; C<sub>2020</sub>: the number of citations of an article in 2020 only.

TABLE 7 The top 13 most productive journals with 100 articles or more.

Journal	TP (%)	IF <sub>2020</sub>	APP	CPP <sub>2020</sub>
Journal of Oral and Maxillofacial Surgery	543 (9.4)	1.895	4.3	22
International Journal of Oral and Maxillofacial Surgery	194 (3.4)	2.789	4.5	21
British Journal of Oral & Maxillofacial Surgery	179 (3.1)	1.651	3.6	19
Operative Dentistry	135 (2.3)	2.44	4.5	23
Oral Surgery Oral Medicine Oral Pathology Oral Radiology and Endodontology	128 (2.2)	N/A	4.3	31
Journal of Dentistry	127 (2.2)	4.379	4.9	34
Archives of Oral Biology	120 (2.1)	2.633	4.9	27
Journal of Endodontics	118 (2.0)	4.171	5.4	27
Dental Materials	115 (2.0)	5.304	5.4	49
American Journal of Orthodontics and Dentofacial Orthopaedics	112 (1.9)	2.65	3.7	22
Medicina Oral Patologia Oral Y Cirugia Bucal	112 (1.9)	2.047	5.0	12
American Journal of Dentistry	111 (1.9)	1.522	4.8	23
British Dental Journal	101 (1.7)	1.626	3.3	19

Note: TP: total number of articles; %: percentage of articles in all third molar articles; IF<sub>2020</sub>: journal impact factor in 2020; APP: number of authors per article; CPP<sub>2020</sub>: citations per paper (TC<sub>2020</sub>/TP).

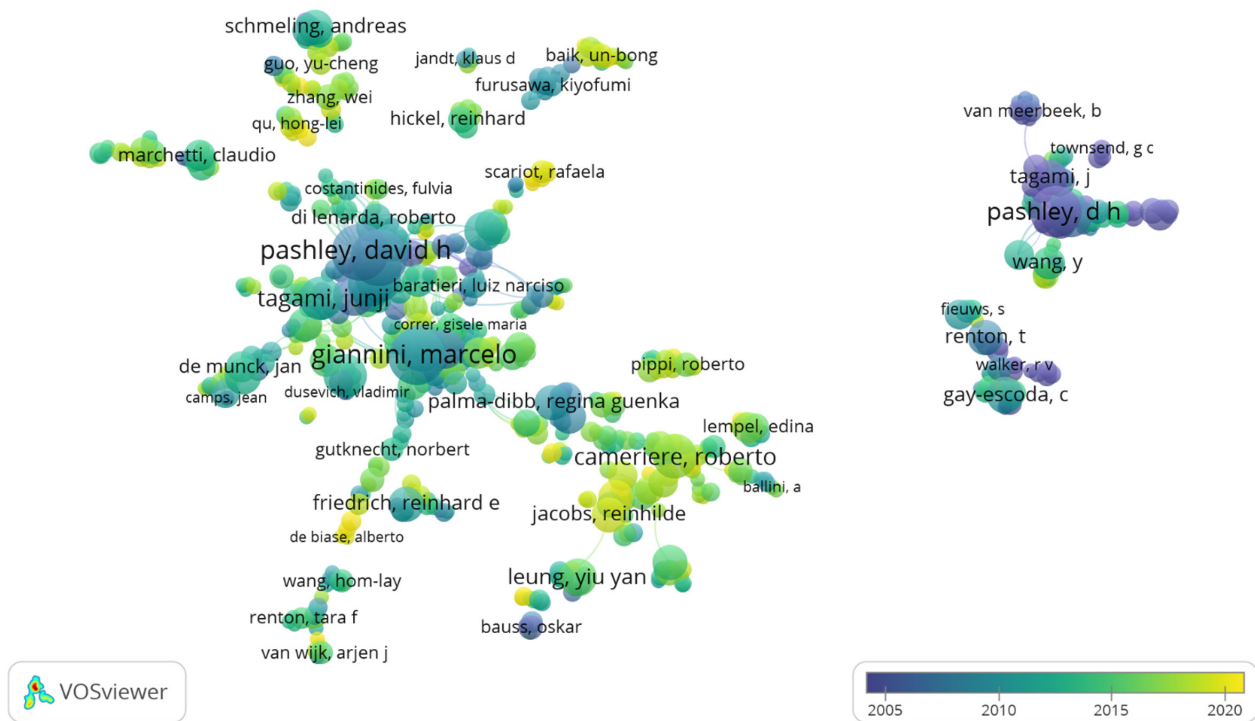


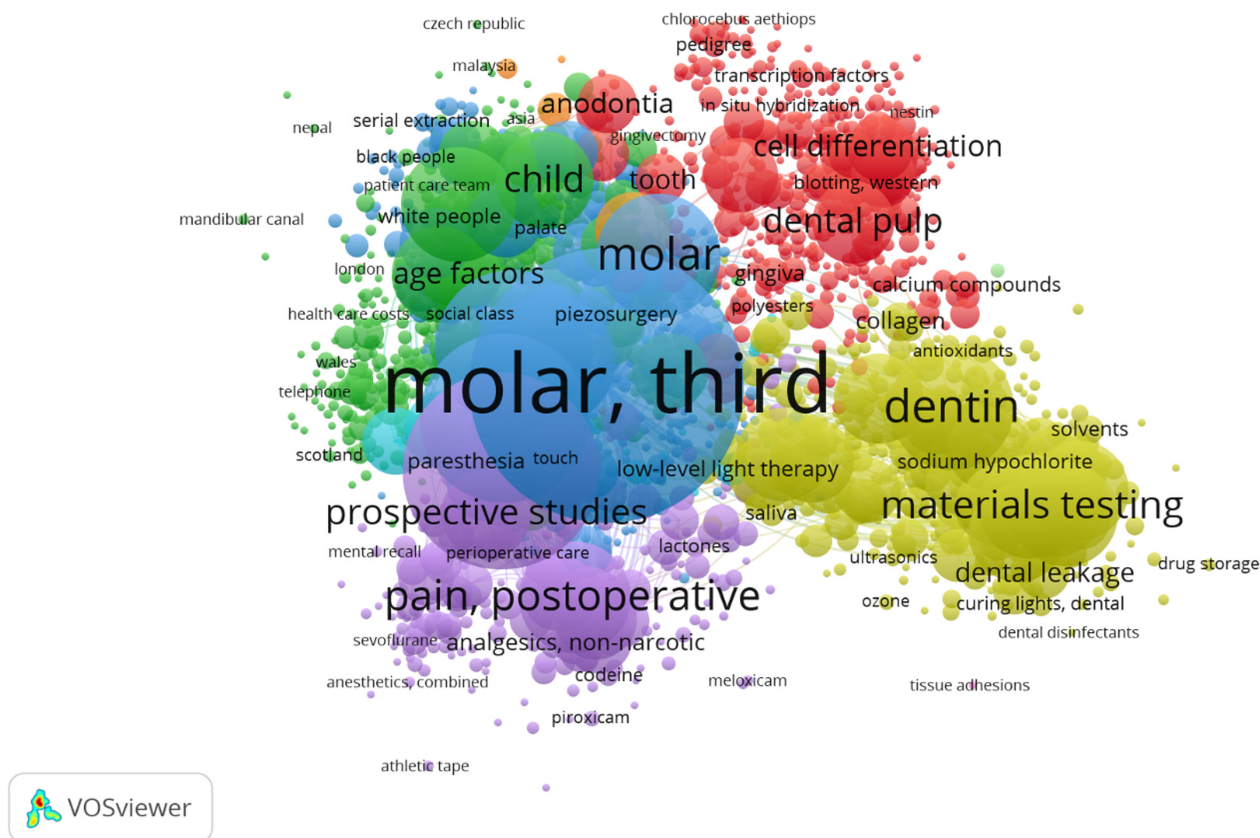
FIGURE 4 Overlay visualization with more prolific authors. The proximity between circles and lines is related to some possible collaboration between the authors. Recently published articles tend to be in yellow and older ones in blue.

## Research foci

The article title, abstract, author keywords and *KeyWords Plus* convey the most important information about the research. Therefore, word distribution analysis is very useful for evaluating research focuses and their development trends in a specific research topic.<sup>32</sup> In the last decade, Ho's group proposed distributions of words in article titles and abstracts, author keywords and *KeyWords Plus* to determine research

focuses and their trends.<sup>32,33</sup> These analyses can minimize various limitations such as the incomplete meaning of individual words in article titles and abstracts, the small sample size of author keywords, and the indirect relationship between *KeyWords Plus* and research topics.<sup>34</sup> Therefore, the article title, article abstract, author keywords, and words in *KeyWords Plus* were checked during the research to show rough trends.<sup>32</sup> Despite the lack of accuracy of the bibliometrics, the authors agree with the available literature and



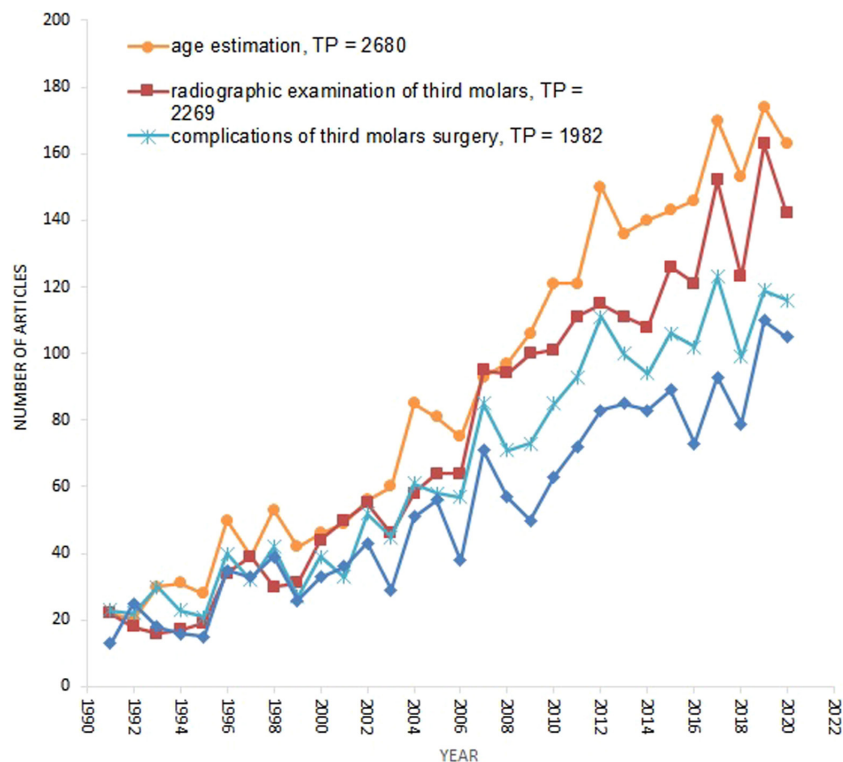


**FIGURE 5** Network visualization of the most common keywords associated with articles on third molar. Removed non-specific keywords such as ‘humans’, ‘adults’ and ‘male’.

**TABLE 8** The 20 most frequently used author keywords.

Author keywords	TP	1991–2020 rank (%)	1991–2000 rank (%)	2001–2010 rank (%)	2011–2020 rank (%)
Third molar	371	1 (9.7)	11 (2.1)	1 (10)	1 (11)
Dentin	193	2 (5.0)	1 (5.6)	2 (6.1)	2 (4.4)
Pain	127	3 (3.3)	21 (1.5)	8 (2.3)	3 (4.1)
Third molar surgery	121	4 (3.1)	16 (1.8)	5 (2.7)	4 (3.6)
Oral surgery	111	5 (2.9)	2 (3.8)	8 (2.3)	5 (3.0)
Enamel	105	6 (2.7)	5 (2.6)	3 (4.8)	17 (1.7)
Third molars	95	7 (2.5)	21 (1.5)	4 (2.8)	7 (2.5)
Age estimation	83	8 (2.2)	108 (0.51)	12 (1.7)	6 (2.6)
Mandible	83	8 (2.2)	65 (0.77)	6 (2.4)	8 (2.3)
Dental pulp	80	10 (2.1)	42 (1)	6 (2.4)	10 (2.1)
Bond strength	69	11 (1.8)	65 (0.77)	12 (1.7)	11 (2.0)
Forensic odontology	68	12 (1.8)	N/A	14 (1.7)	9 (2.1)
Inferior alveolar nerve	64	13 (1.7)	65 (0.77)	17 (1.6)	13 (1.9)
Tooth extraction	64	13 (1.7)	11 (2.1)	25 (1.2)	14 (1.8)
Microtensile bond strength	61	15 (1.6)	N/A	11 (2.0)	18 (1.6)
Dentine	57	16 (1.5)	3 (3.3)	10 (2.1)	48 (0.87)
Hypodontia	51	17 (1.3)	11 (2.1)	14 (1.7)	35 (1.0)
Trismus	51	17 (1.3)	N/A	48 (0.87)	15 (1.8)
Extraction	49	19 (1.3)	N/A	37 (1.0)	19 (1.6)
Molar	49	19 (1.3)	28 (1.3)	37 (1.0)	26 (1.4)

Note: TP: number of articles; %: percentage in each period.



**FIGURE 6** Development trends of hotspots third molar surgery related articles, including age estimation, radiographical examination of third molars, complications of third molars surgery and local anaesthesia in third molars surgery.

suggest a suitable choice of MeSH keywords<sup>35</sup> to disseminate articles, identify research topics and analyse research priorities.<sup>36–38</sup> The VOSviewer software could be very useful in situations like these (Figures 4 and 5—keywords: Network visualization of the most common keywords associated with articles on third molar). Removed non-specific keywords such as ‘humans’, ‘adults’ and ‘male’.

Bibliometrics is a quantitative method that allows researchers and scientists to evaluate numerous, unlimited peer-reviewed publications in a specific scientific field. It is worth noting that there is no association between the number of citations and the quality of the articles published. Due to the inherent delays between publishing and breakthroughs and innovations in treatment modalities, highly cited papers identified in the bibliometrics may not represent the latest technological advances applied in the clinical setting. While bibliometric analysis can reveal research trends, specific institutions with focused research and outputs on a topic of interest, it cannot provide evidence and recommendations regarding treatment guidelines. Strengths of bibliometrics include mapping the literature, identifying key opinion leaders and developing networks for collaborative research.

The 20 most frequently used author keywords in third molar research and their distribution in three sub-periods (1991–2000, 2001–2010 and 2011–2020) are listed in Table 8.

Considering research articles on third molars and after analysing the distribution of authors’ keywords, title keywords, abstract keywords and keywords plus, the authors summarized the research hotspots into four topics (Figure 6).

These four topics shown support the efforts of researchers and academicians over the years to identify the role of third molars in age estimation, the radiographical examination of third molars, the reduction of postoperative complications after third molar surgery and the study of the effectiveness of different local anaesthetics to control pain in third molars surgery. It seems that all the above topics have gradually increased since 1991 and then in 2006. These publications increased steadily to reach the peak in 2020. All the above themes represent the spectrum of research activities that have taken place since 1991 to 2020. Thus, authors can conclude and visualize that in the future, a similar topic of research will continue to dominate scientific investigations and publications in the field of third molars.

## CONCLUSION

The results revealed that international collaboration accounted for a higher number of citations, but no correlation was found between the number of citations and the quality of the published articles. Furthermore, highly cited articles identified in the bibliometric analysis may not represent the latest technological advances applied in the clinical setting. It was noted that academic controversy, a lack of consensus and notable different epidemiological features were prevalent in this field. Over the years, researchers and academicians have focused on four topics related to third molars: age estimation, radiographical examination, reducing postoperative complications and the effectiveness of local anaesthetics in pain control. To better understand

these factors, further in-depth discussions and analyses are required. Despite these challenges, the study provided relevant data that can help readers stay updated with the latest scientifically sound evidence in the field.

### AUTHOR CONTRIBUTIONS

All authors contributed to the study conception and design.

### CONFLICT OF INTEREST STATEMENT


The authors have no relevant financial or non-financial interests to disclose.

### DATA AVAILABILITY STATEMENT

The datasets generated during and/or analysed during the current study are available from the corresponding author on reasonable request.

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### REFERENCES

- Al-Moraissi EA, Al-Zendani EA, Al-Selwi AM. Efficacy of submucosal injection of chymotrypsin, Oral Serratiopeptidase or Oral dexamethasone in reducing postoperative complications following impacted lower third molar surgery: a prospective, randomized, double-blind, controlled clinical trial. *Front Oral Health*. 2020;1:575176.
- Sifuentes-Cervantes JS, Carrillo-Morales F, Castro-Núñez J, Cunningham LL, Van Sickels JE. Third molar surgery: past, present, and the future. *Oral Surg Oral Med Oral Pathol Oral Radiol*. 2021;132:523–31.
- Kazancıoğlu HO, Kurklu E, Ezirganlı S. Effects of ozone therapy on pain, swelling, and trismus following third molar surgery. *Int J Oral Maxillofac Surg*. 2014;43:644–8.
- Gelesko S, Long L, Faulk J, Phillips C, Dicus C, White RP. Cryotherapy and topical minocycline as adjunctive measures to control pain after third molar surgery: an exploratory study. *J Oral Maxillofac Surg*. 2011;69:e324–32.
- Zandi M, Amini P, Keshavarz A. Effectiveness of cold therapy in reducing pain, trismus, and oedema after impacted mandibular third molar surgery: a randomized, self-controlled, observer-blind, split-mouth clinical trial. *Int J Oral Maxillofac Surg*. 2016;45:118–23.
- Gassling V, Douglas T, Warnke PH, Açil Y, Wiltfang J, Becker ST. Platelet-rich fibrin membranes as scaffolds for periosteal tissue engineering. *Clin Oral Implants Res*. 2010;21:543–9.
- Ogundipe OK, Ugboko VI, Owotade FJ. Can autologous platelet-rich plasma gel enhance healing after surgical extraction of mandibular third molars? *J Oral Maxillofac Surg*. 2011;69:2305–10.
- Al-Moraissi EA, Elmansi YA, Al-Sharaee YA, Alrmali AE, Alkhutari AS. Does the piezoelectric surgical technique produce fewer postoperative sequelae after lower third molar surgery than conventional rotary instruments? A systematic review and meta analysis. *Int J Oral Maxillofac Surg*. 2016;45:383–91.
- Amarillas-Escobar ED, Toranzo-Fernández JM, Martínez-Rider R, Noyola-Frías MA, Hidalgo-Hurtado JA, Serna VMF, et al. Use of therapeutic laser after surgical removal of impacted lower third molars. *J Oral Maxillofac Surg*. 2010;68:319–24.
- Ho Y-S. Top-cited articles in chemical engineering in Science Citation Index Expanded: a bibliometric analysis. *Chin J Chem Eng*. 2012;20:478–88.
- Garfield E. KeyWords plus: ISI's breakthrough retrieval method. Part 1. Expanding your searching power on current contents on diskette. *Curr Contents*. 1990;32:5–9.
- Fu H-Z, Ho Y-S. Top cited articles in thermodynamic research. *J Eng Thermophys*. 2015;24:68–85.
- Fu HZ, Wang MH, Ho YS. The most frequently cited adsorption research articles in the science citation index (Expanded). *J Colloid Interface Sci*. 2012;379:148–56.
- Ho YS, Fahad Halim AFM, Islam MT. The trend of bacterial nanocellulose research published in the Science Citation Index Expanded from 2005 to 2020: a bibliometric analysis. *Front Bioeng Biotechnol*. 2021;9:795341.
- Li Z, Ho Y-S. Use of citation per publication as an indicator to evaluate contingent valuation research. *Scientometrics*. 2008;75:97–110.
- Ho YS. Comment on: trends in research related to high myopia from 2010 to 2019: a bibliometric and knowledge mapping analysis. *Int J Ophthalmol*. 2022;15:178–9.
- Monge-Nájera JaH YS. Guatemala articles in the Science Citation Index Expanded: bibliometry of subjects, collaboration, institutions and authors. *Rev Biol Trop*. 2018;66:312–20.
- Riesenberg D, Lundberg GD. The order of authorship: who's on first? *JAMA*. 1990;264:1857.
- Chiu W-T, Ho Y-S. Bibliometric analysis of tsunami research. *Scientometrics*. 2007;73:3–17.
- Ho Y-S, Mukul SA. Publication performance and trends in mangrove forests: a bibliometric analysis. *Sustainability*. 2021;13:12532.
- Morsczeck C, Götz W, Schierholz J, Zeilhofer F, Kühn U, Möhl C, et al. Isolation of precursor cells (PCs) from human dental follicle of wisdom teeth. *Matrix Biol*. 2005;24:155–65.
- Olze A, Bilanz D, Schmidt S, Wernecke K-D, Geserick G, Schmeling A. Validation of common classification systems for assessing the mineralization of third molars. *Int J Leg Med*. 2005;119:22–6.
- Bui CH, Seldin EB, Dodson TB. Types, frequencies, and risk factors for complications after third molar extraction. *J Oral Maxillofac Surg*. 2003;61:1379–89.
- Valmaseda-Castellón E, Berini-Aytés L, Gay-Escoda C. Inferior alveolar nerve damage after lower third molar surgical extraction: a prospective study of 1117 surgical extractions. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2001;92:377–83.
- Tantanapornkul W, Okouchi K, Fujiwara Y, Yamashiro M, Maruoka Y, Ohbayashi N, et al. A comparative study of cone-beam computed tomography and conventional panoramic radiography in assessing the topographic relationship between the mandibular canal and impacted third molars. *Oral Surg Oral Med Oral Pathol Oral Radiol Endod*. 2007;103:253–9.
- Olze A, Schmeling A, Taniguchi M, Maeda H, van Niekerk P, Wernecke KD, et al. Forensic age estimation in living subjects: the ethnic factor in wisdom tooth mineralization. *Int J Leg Med*. 2004;118:170–3.
- Renton T, Hankins M, Sproate C, McGurk M. A randomised controlled clinical trial to compare the incidence of injury to the inferior alveolar nerve as a result of coronectomy and removal of mandibular third molars. *Br J Oral Maxillofac Surg*. 2005;43:7–12.
- Blondeau F, Daniel NG. Extraction of impacted mandibular third molars: postoperative complications and their risk factors. *J Can Dent Assoc*. 2007;73:325.
- Gunst K, Mesotten K, Carbonez A, Willems G. Third molar root development in relation to chronological age: a large sample sized retrospective study. *Forensic Sci Int*. 2003;136:52–7.
- Bataineh AB. Sensory nerve impairment following mandibular third molar surgery. *J Oral Maxillofac Surg*. 2001;59:1012–7; discussion 1017.
- Ho Y-S. Classic articles on social work field in social science citation index: a bibliometric analysis. *Scientometrics*. 2014;98:137–55.
- Wang C-C, Ho Y-S. Research trend of metal-organic frameworks: a bibliometric analysis. *Scientometrics*. 2016;109:481–513.
- Zhang G, Xie S, Ho Y-S. A bibliometric analysis of world volatile organic compounds research trends. *Scientometrics*. 2010;83:477–92.

34. Fu HZ, Ho YS. Independent research of China in Science Citation Index Expanded during 1980-2011. *J Informet.* 2013;7:210–22.
35. US National Library of Medicine National Institute of Health. Principles of MEDLINE Subject Indexing [Internet]. Available from: <https://www.nlm.nih.gov/bsd/disted/meshtutorial/principlesofmedlinesubjectindexing/principles/index.html>
36. Balel Y. Bibliometric analysis of international publication trends in impacted third molar surgery research (2000–2020). *Br J Oral Maxillofac Surg.* 2021;59:1220–6.
37. Grillo R. Orthognathic surgery: a bibliometric analysis of the top 100 cited articles. *J Oral Maxillofac Surg.* 2021;79:2339–49.
38. Grillo R. Bibliometric trending analysis of complications related to facial non-surgical aesthetic procedures: a retrospective study. *Prosthodontics.* 2021;71:228–33.

## SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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