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Original Article

Bibliometric Analysis of Maxillary Expansion Publications Trends

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Main Points

- Maxillary expansion is associated with orthodontics and many other disciplines.
- Maxillary expansion studies have remained popular over the years and have been published in many high-impact journals.

ABSTRACT

Objective: Maxillary expansion is a common treatment in clinical orthodontics and can be performed in a wide age range using different methods. This bibliometric analysis aims to provide an overview of research on maxillary expansion.

Methods: A literature search was performed in the Web of Science database, and publications related to maxillary expansion between 1970 and 2023 were included. Data, including titles, abstracts, keywords, countries, regions, and references, were exported and analyzed within the scope of the bibliometric indicators.

Results: The study was conducted on 2633 publications. Between 1970 and 2023, research on maxillary expansion showed a general upward trend in the number of publications. From the analyzed publications, we observed that rapid maxillary expansion (RME) was the most common type of maxillary expansion, accounting for 78% of all publications. Most publications originated from the United States (24.3%), and these articles were also the most cited (17180). Lorenzo Franchi contributed the most publications (85, 3.2%) and was cited 2830 times for maxillary expansion. The highest number of publications was from the University of Sao Paolo (119), and the most cited institution was the University of Florence (3287).

Conclusion: The bibliometric indicators showed a rapid increase in the number of published works on the topic of maxillary expansion, particularly in recent years. Advances in patient evaluation (3D imaging, modeling) and application methods (mini-screws, clear aligners) appear to have helped to maintain the popularity of maxillary expansion. We also observed that maxillary expansion is associated with several other specialties in addition to dentistry.

Keywords: Bibliometric analysis, maxillary expansion, rapid maxillary expansion

INTRODUCTION

Posterior crossbite, the prevalence of which is reported to vary between 8% and 22%, is one of the most common malocclusions in deciduous and early mixed dentition.[1-5] Studies have shown that this problem does not correct spontaneously, and orthodontic intervention is needed.[1] Maxillary expansion is an effective orthodontic treatment for correcting malocclusion caused by transverse maxillary deficiency or posterior crossbite occurs.[6-8] In maxillary expansion treatment initiated in the early mixed dentition stage, the desired effect can be achieved

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with lower forces because the mid-palatal suture has not yet been fused. However, for older children (12 years and older), greater forces may be required to achieve maxillary expansion in the early permanent dentition.[7] Maxillary expansion treatment can be performed in rapidly, semi-rapidly, or slowly using fixed or removable appliances.[7,9] When the expansion occurs at a rate of 0.5 mm/day, it is referred to as "rapid"; when expansion is achieved at a rate of 1 mm/week, it is referred to as "semi-rapid". When expansion occurs at a rate of 0.5 mm/week, it is named as "slow".[7,10] Beyond orthodontic purposes, some studies have shown that maxillary expansion therapy has positive effects on nocturnal enuresis, conductive hearing loss, nasal airway width, and resistance.[11-13]

Bibliometric analysis is an important statistical tool for mapping state-of-the-art research areas and it comprehensively describes the relationship between data by creating an information map.[14-16] Bibliometric analysis provides the opportunity to statistically evaluate the entire literature body according to specific criteria.[17,18] Bibliometric studies also allow comparisons between countries, institutions, and authors. The main objectives of such studies are to identify the analyzed subject's chronological trends, show the number of citations, and highlight evidence-based studies.[19,20] By creating a relationship map between the data from the maxillary expansion procedure, which is a fundamental orthodontic treatment method, we can obtain summarized and precise information about the studies, authors, and countries.

Although there have been many studies on maxillary expansion over the years, no bibliometric analysis of this topic has been performed. In this study, we aimed to provide an overview of the subject and give researchers an idea about future study priorities by identifying the most frequently used keywords, most preferred journals, most cited publications, researchers, institutions, countries, and collaborations in publications related to maxillary expansion.

METHODS

The search was conducted in the Web of Science (WoS) database, initially hosted by the Institute for Scientific Information and later maintained by Clarivate Analytics. The literature search was conducted in February 2023. Articles published before February 27, 2023, were screened, and pilot searches were conducted to develop the search strategy. The electronic search was limited to "topics" including titles, abstracts, and keywords. Filtering was performed to enhance and limit the search. During filtering, "article", "proceeding paper", "review", and "early access" were selected as document types. In the screening process, the article language was set to English, and only articles published in this language were included in the study.

By using the "analyze results" option in the WoS database, it was possible to access information on which authors had the most articles and citations on this topic, as well as which countries and universities conducted more research. In addition, graphical representations of these data were accessed from the "analyze results" option, and these graphs were added to the study.

Statistical Analysis

The VOSviewer (Center for Science and Technology Studies, Leiden University, Holland) bibliometric analysis program was used to analyze the data obtained.[21,22] VOSviewer version 1.6.18, released on January 24, 2022, was downloaded free of charge from the program's official site.[19] Data in ".txt" and ".xls" types, which were previously exported, transferred to the VOSviewer program and processed.[22-24] The number of collaborations and citations was visualized by network type or overlap with the help of VOSviewer software. For the co-authors, a network-type visualization was presented in which bubbles of the same color formed clusters, indicating the close collaborations made due to the research. In this visual map, the size of the bubble reflected the number of publications, the distance between the bubbles reflected the relationship between the two items, and the color of each dot has different meanings in different visual maps.

RESULTS

A total of 2711 articles were found when "palat* expan*" OR "maxill* expan*" OR "midpalatal suture*" was typed into the search bar. In the first search, the titles and abstracts of the articles were scanned by a single author, and only articles related to maxillary expansion were included. Then, the full texts of the articles suspected to be relevant to the topic were opened and examined in detail. A total of 78 articles were found to be irrelevant and eliminated. After all these screening and filtering procedures, the study was conducted on 2633 publications, which were published from 1970 to 2023 according to the WoS database. When a separate investigation was made of these publications as "RME" OR "rapid maxil* exp*" OR "rapid pal* exp*", it was seen that 2033 out of 2633 publications were related to RME. It was observed that the number of published articles increased each year compared with the previous year. Publications on maxillary expansion received 47794 citations; 21981 citations were from authors other than the authors themselves. The average number of citations per article was 18.15, and the H index was 88. A large proportion (87.771%) of the publications on maxillary expansion were "article" type documents. Information on specific topics, such as title, author, journal, publication date, total number of citations, and annual average, was obtained from the database, and tables were created. The most cited 20 articles on "maxillary expansion" are shown in Table 1. Since 1970, the annual number of articles and citations is shown in Figure 1. The distribution of network structures resulting from bibliometric analyses according to authors, institutions, and countries are shown in Figures 2-4, respectively). Lorenzo Franchi seems to have been the most active author on maxillary expansion (85 articles, 2830 citations). Data related to authors, countries, and institutions regarding maxillary expansion are presented in Tables 2-4.

Table 1. Most cited 20 articles

Titles	Authors	Journals	Publication year	Total citations	Average per year	The type of study
Diagnosis And Management Of Childhood Obstructive Sleep Apnea Syndrome	Marcus CL, Brooks LJ, Draper KA, Gozal D, Halbower AC, Jones J, Schechter MS, Ward SD, Sheldon SH, Shiffman RN, Lehmann C, Spruyt K; American Academy of Pediatrics	Pediatrics	2012	867	72.25	Article
Palatal Expansion: The Just Beginning Of Dentofacial Orthopedics	Haas AJ	American Journal Of Orthodontics	1970	471	8.72	Article
Skeletal And Dental Changes Accompanying Rapid Midpalatal Suture Opening	Wertz RA	American Journal Of Orthodontics	1970	445	8.24	Review
Obstructive Sleep Disordered Breathing in 2- to 18-year-old Children: Diagnosis And Management	Kaditis AG, Alvarez MLA, Boudewyns A, Alexopoulos EI, Ersu R, Joosten K, Larramona H, Miano S.	European Respiratory Journal	2016	371	46.38	Article
Maxillary Expansion: Clinical implications	Bishara SE, Staley RN	American Journal Of Orthodontics And Dentofacial Orthopedics	1987	292	7.89	Article
Long-Term Post-Treatment Evaluation Of Rapid Palatal Expansion	Haas, AJ	Angle Orthodontist	1980	247	5.61	Article
Treatment Timing For Rapid Maxillary Expansion	Baccetti T, Franchi L, Cameron CG, Mcnamara JA Jr	Angle Orthodontist	2001	241	10.48	Article
Skeletal Effects Of Early Treatment for Class Iii Malocclusion With Maxillary Expansion and Face Mask Therapy	Baccetti T, Mcgill JS, Franchi L, Mcnamara JA, Tollaro I	American Journal Of Orthodontics And Dentofacial Orthopedics	1998	236	9.08	Article
Stimulatory Effects Of Low-Power Laser Irradiation On Bone Regeneration in Midpalatal Sutures during Expansion in Rats	Saito S, Shimizu N	American Journal Of Orthodontics And Dentofacial Orthopedics	1997	228	2.44	Article
Practice Parameters for Respiratory Indications For Polysomnography In Children	Aurora RN, Zak RS, Karippot A, Lamm CI, Morgenthaler TI, Auerbach SH, Bista SR, Casey KR, Kristo DA, Ramar K	Sleep	2011	194	17.64	Article
A Review Of Maxillary Expansion in Relation to the Rate of Expansion and Patient Age	Bell RA	American Journal Of Orthodontics And Dentofacial Orthopedics	1982	195	4.64	Article
Clinical Recommendations Regarding the Use of Cone Beam Computed Tomography In Orthodontics. Position Statement of the American Academy Of Oral And Maxillofacial Radiology	Evans CA, Scarfe WC, ; Ahmad M, Cevidanes LHS, Ludlow JB, Palomo JM, Simmons KE, White SC Group Author: Amer Acad Oral Maxillofacial Radiography	Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology	2013	194	17.64	Article
Effectiveness of Protraction Face Mask Therapy: A Meta-Analysis	Kim JH, Viana MAG, Graber TM, Omerza FF, Begole EA	American Journal Of Orthodontics And Dentofacial Orthopedics	1999	188	7.52	Meta Analysis
Long-Term Effects Of Class Iii Treatment With Rapid Maxillary Expansion And Facemask Therapy Following Fixation	Westwood PV, McNamara JA Jr, Baccetti T, Franchi L, Sarver DM	American Journal Of Orthodontics And Dentofacial Orthopedics	2003	184	8.76	Article
Rapid Maxillary Expansion-Tooth Tissue-Borne Versus Tooth-Borne Expanders: A Computed Tomography Evaluation Of Dentoskeletal Effects	Garib DG, Henriques JFC, Janson G, Freitas MR, Coelho RA.	Angle Orthodontist	2005	182	9.58	Article

Table 1. Continued

Title	Author	Journals	Publication year	Total citations	Average per year	The type of study
Cytokine Expression Patterns on the Compression and Tension Sides Of The Periodontal Ligament During Orthodontic Tooth Movement In Humans	Garlet TP, Coelho U, Silva JS, Garlet GP	European Journal Of Oral Sciences	2007	178	10,47	Article
Surgically Assisted Rapid Palatal Expansion: A Literature Review	Suri L, Taneja P	American Journal Of Orthodontics And Dentofacial Orthopedics	2008	175	10,94	Article
Periodontal Effects Of Rapid Maxillary Expansion with Tooth-Tissue- and Tooth-Borne Expanders: A Computed Tomography Evaluation	Garib DG, Henriques JFC, Janson G, Freitas MR, Fernandes AY	American Journal Of Orthodontics And Dentofacial Orthopedics	2006	175	9,72	Article
Transpalatal Distraction as a Method for Maxillary Expansion	Mommaerts MY	British Journal of Oral and Maxillofacial Surgery	1999	175	7	Article
Arch Perimeter Changes during Rapid Palatal Expansion	Adkins MD, Nanda RS, Currier GF	American Journal Of Orthodontics And Dentofacial Orthopedics	1990	175	5,15	Article

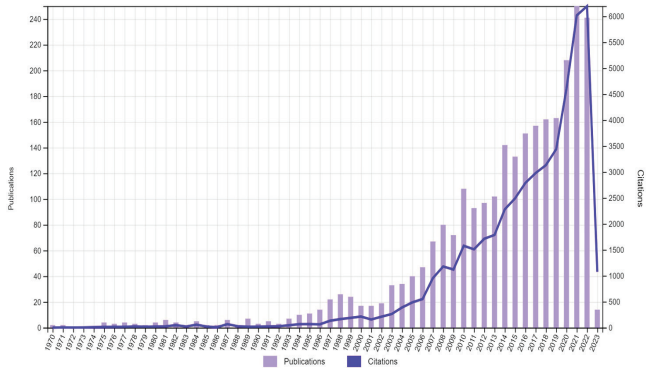

Figure 1. Annual number of published articles from 1970 to 2023 with maxillary expansion

The largest number of publications was from the United States (640), followed by Italy (443), Turkey (348), and Brazil (348). In terms of institutions, the University of Sao Paolo ranked first with 119 publications. Most RME studies were published in American Journal of Orthodontics and Dentofacial Orthopedics (AJO-DO), Angle Orthodontist, and European Journal of Orthodontics. The keywords most frequently used by the authors are listed in Table 5.

DISCUSSION

While studies on "maxillary expansion" have been increasing since the 1970s, it is noteworthy that the most studied expansion method is "rapid maxillary expansion (RME)". In addition to non-invasive RME methods, surgically assisted RME has been widely reported in the literature. When the studies were analyzed over 10-year periods, the dental and skeletal effects of maxillary expansion were extensively examined between 1970 and 1979, and many experimental studies were performed on monkeys.

Between 1980 and 1989, among other studies, publications on the effects of RME on the nasal airway were noteworthy. Studies investigating the health effects of maxillary expansion increased between 1990 and 1999. Between 2000 and 2009, the finite element method began to attract attention in the literature. Since 2010, a significant body of research has been examining the effects of maxillary expansion on medical conditions, particularly obstructive sleep apnea. As a result of the widespread use of cone-beam computed tomography in dentistry, studies evaluating the effects of maxillary expansion three-dimensionally were common during this period. Again, during this period, it was observed that mini-screw and mini-implant-supported maxillary expansion studies started to become widespread and reached their highest level in the last few years. From 2020 to the first quarter of 2023, there was a greater focus on reviews, systematic reviews, and meta-analyses. The fact that 24.8% of all reviews and meta-analyses on maxillary expansion were published during this period indicates that literature, data, and study analyses replaced clinical trials due to the coronavirus disease-2019 pandemic.

Maxillary narrowing requiring maxillary expansion, is a global problem. The worldwide distribution of data and high number of publications are attributed to the fact that maxillary expansion is a treatment of international interest. The total number of publications from the United States, Italy, Turkey, and Brazil was higher than that from the rest of the world.

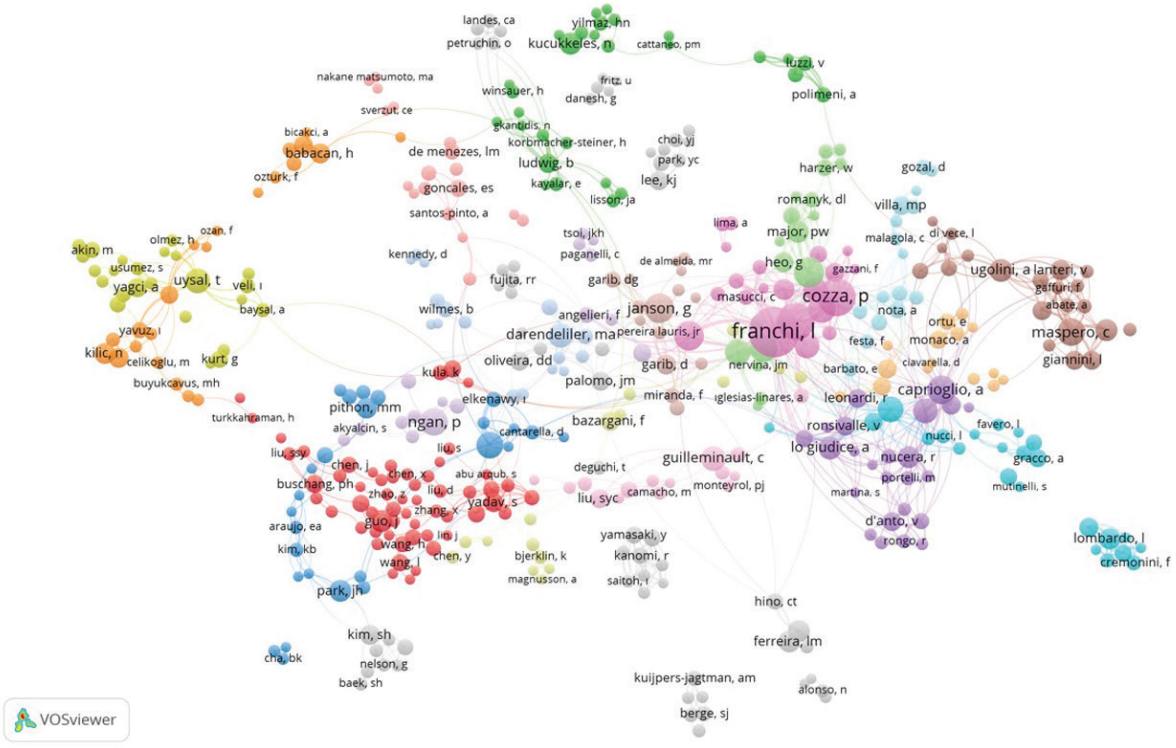

Figure 2. Collaboration networks between authors

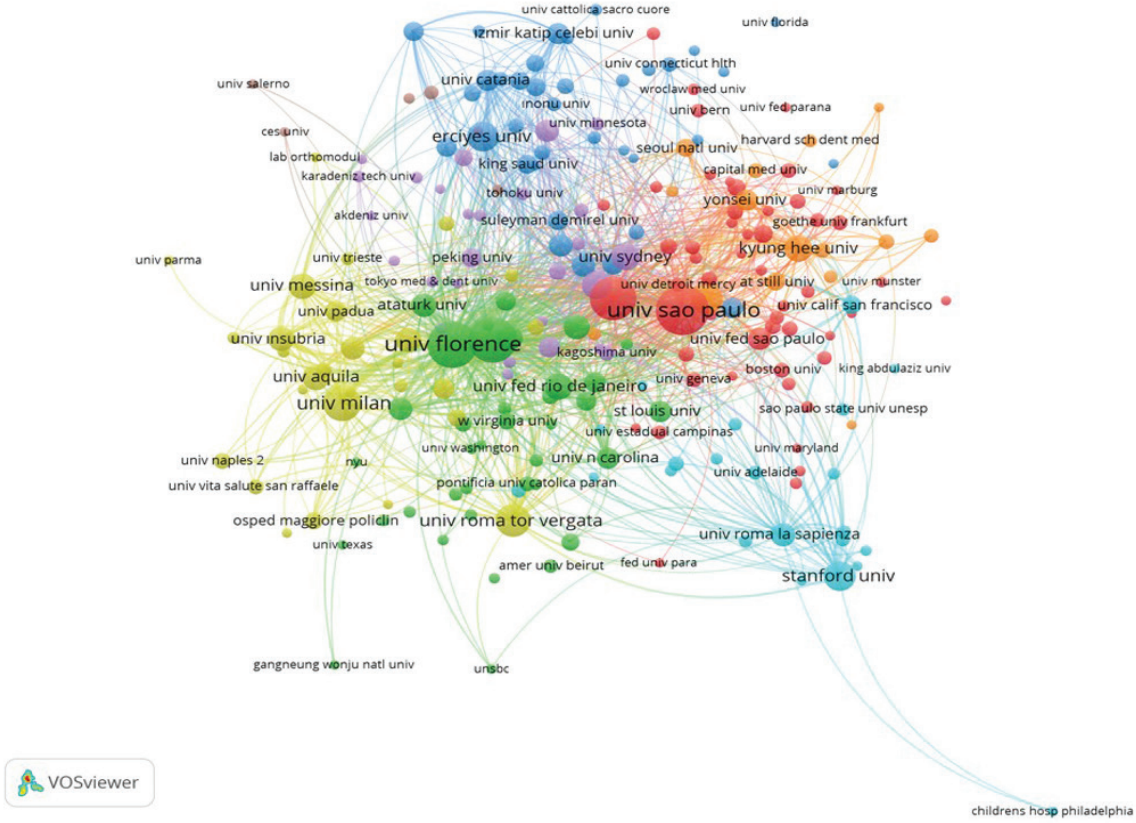

Figure 3. Collaboration networks between institutions

When countries were evaluated according to the number of citations, the USA, Italy, Turkey, and Brazil were ranked, respectively. In the present study, similar to the literature, the USA was the most cited country in the bibliometric studies.[25,26] The number of citations in the United States, which ranks first, is approximately the sum of the number of citations from Italy, Turkey, and Brazil. The high number of publications in the United States also accounts for the high number of citations.

The University of Sao Paulo has the highest number of publications on maxillary expansion. The literature review revealed that the same university also ranked highest in publications related to cleft palate.[27] Intense use of maxillary expansion in the treatment of cleft lip and palate patients may partially explain this finding.

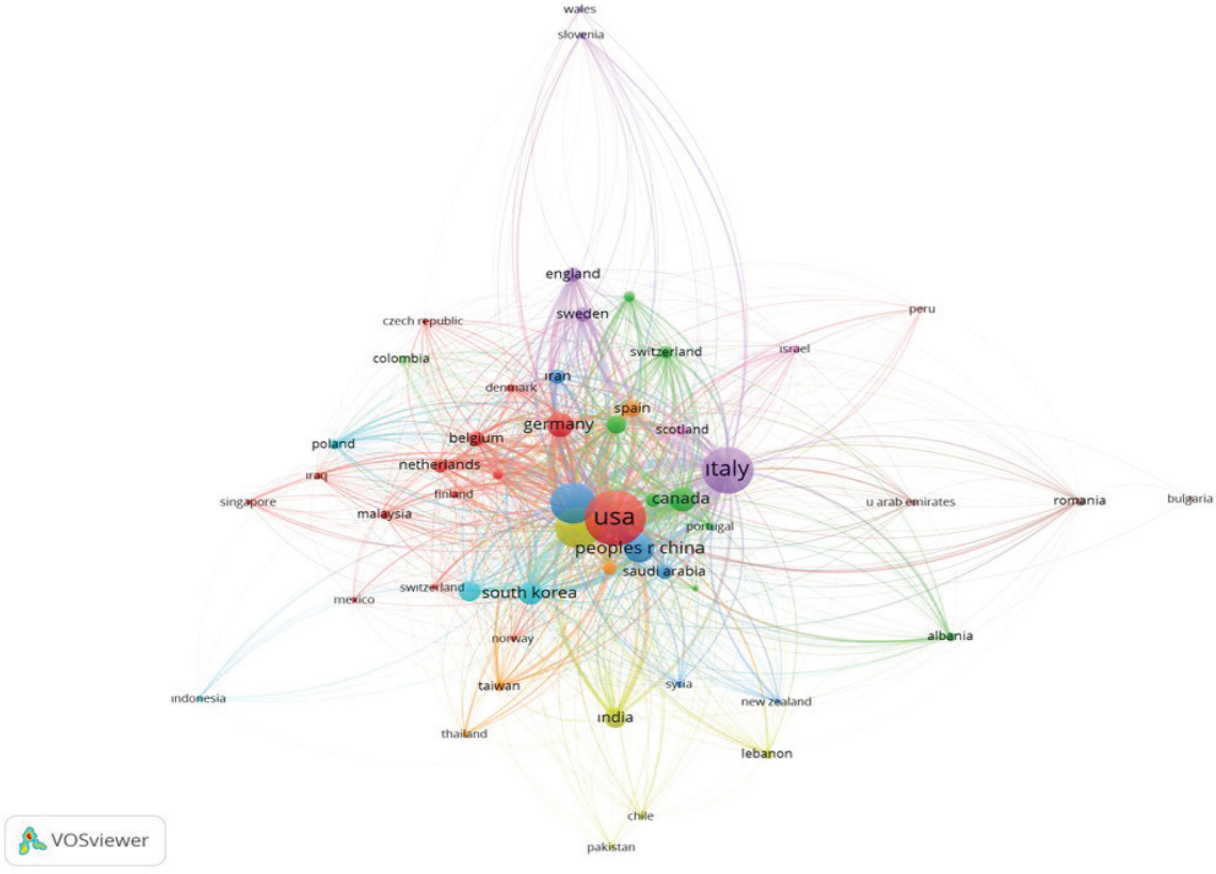

Figure 4. Collaboration networks between countries

Table 2. Top 10 authors

Authors	Institutions	Country or region	Number of citations	Number of articles
Franchi L	University of Florance	Italy	2830	85
Bacetti T	University of Florance	Italy	2495	47
Mcnamara JA	University of Michigan	USA	2448	51
Gozal D	University of Missouri	USA	1206	8
Lagravere MA	University of Alberta	Canada	1052	36
Guillerminaut C	Stanford University	USA	939	21
Cozza P	St. Camillus International University of Health and Medical Sciences	Italy	872	48
Villa MP	Sapienza University of Rome, Italy	Italy	825	12
Ngan P	West Virginia University	USA	752	25
Flores-Mir C	University of Alberta	Canada	607	25

Table 3. The 10 most contributing institutions

Institutions	Country or region	Number of articles	Number of citations
University of Florence	Italy	102	3287
University of Michigan	USA	97	3181
University of São Paulo	Brazil	119	1824
University of California, Los Angeles	USA	46	1319
University of Alberta	Canada	86	1292
Sapienza University of Rome, Italy	Italy	45	1254
Stanford University	USA	45	1250
University of Rome, Tor Vergata	Italy	57	1010
Carolina University	USA	25	791
University of Illinois	USA	29	777

Table 4. The ten most contributing countries or regions

Country or region	Number of articles	Number of citations
USA	640	17180
Italy	443	8085
Turkey	348	5305
Brazil	348	4647
Canada	127	2305
Germany	120	1941
South Korea	106	1883
China	163	1539
Belgium	44	1456
Netherlands	40	1355

Table 5. List of keywords with a total link strength greater than 10

Keywords	Occurrence
Rapid Maxillary Expansion	313
Maxillary Expansion	227
Orthodontics	147
Palatal Expansion	121
Obstructive Sleep Apnea	68
Rapid Palatal Expansion	68
Malocclusion	65
Orthognatic Surgery	64
Class III Malocclusion	64
Cone-beam Computed Tomography	58

Although most of the reviewed articles were published in journals in the orthodontic specialty, some were published in journals with high-impact factors in other disciplines, such as surgery and otorhinolaryngology. This indicates that maxillary expansion is not only a dental issue but also a multidisciplinary issue involving other fields.

In a bibliometric study, AJO-DO, Angle Orthodontist, and the European Journal of Orthodontics received the most citations.[20] According to the results of our study in the field of maxillary expansion, these journals received the most citations in support of the study. Again, most publications on this subject were published in these journals. The authors' choice was most likely based on the fact that these three scientific journals are popular, reputable, and have a high impact factor in the field of orthodontics. Another parameter to consider, is the frequency of publication of orthodontic journals (AJO-DO, 12 issues per year; The Angle Orthodontist and European Journal of Orthodontics, 6 issues per year). This may have resulted in a greater amount of content (number of articles).

When the top 20 most cited articles were individually examined, it was observed that only 4 of them were open access. It is a well-established fact in the literature that open access articles tend to receive more citations due to their ease of accessibility.[28,29] In fact, when we checked the number of citations received per year, these 4 open access studies reached their highest annual citation counts. On the other hand, the majority of the most cited articles in this study are not open access, which can be explained by these studies serving as fundamental studies in this field and often with earlier publication dates (Table 1).

CONCLUSION

- Based on the findings of this bibliometric analysis, the following conclusions were drawn:
- It has been observed that maxillary expansion is associated with orthodontics and many other disciplines.
- Maxillary expansion studies have remained popular over the years and have been published in many high-impact journals.
- Maxillary expansion is commonly performed over a wide age range using a variety of appliances and auxiliary units.
- It was determined that maxillary expansion was mainly performed using the rapid method (RME), and most research was conducted using this method.

Ethics

Ethics Committee Approval: Ethics committee approval is not required for this study.

Informed Consent: Not applicable.

Author Contributions: Concept - A.K., A.Ö.; Design - A.K., A.Ö.; Data Collection and/or Processing - A.K., M.A.K., Y.S.G.; Analysis and/or Interpretation – A.K., M.A.K.; Literature Review – Y.S.G.; Writing - A.K., A.Ö.

Conflict of Interest: The authors have no conflicts of interest to declare.

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