

Evaluation of the Temporomandibular Joint Osteoarthritis via Web of Science Database: A Bibliometric Analysis

Web of Science Veritabanı Üzerinden Temporomandibular Eklem Osteoartritinin Değerlendirilmesi: Bir Bibliyometrik Analiz

Sema POLAT¹, Mahmut TUNC², Ufuk Can AKSAY¹, Pınar GOKER¹

¹ Cukurova University Faculty of Medicine, Department of Anatomy, Adana, Türkiye

² Baskent University, Vocational School of Health Services, Department of Therapy and Rehabilitation, Adana, Türkiye

Özet

Amaç: Temporomandibular eklem osteoartriti (TMEOA), temporomandibular bozuklukların en yaygın alt tipi olarak gösterilmiştir. Bu çalışmanın amacı, Web of Science tarafından indekslenen dergilerde yayınlanan temporomandibular eklem osteoartriti makalelerinin araştırma verimliliğini bibliyometrik analiz yöntemini kullanarak analiz etmektir.

Gereç ve Yöntemler: 9 Haziran 2024'te Web of Science Core Collection veri tabanında sistematik arama yapıldı. TMEOA aramasında toplam 1883 doküman belirlendi. Son olarak, dışlama kriterlerinden sonra, bu çalışmaya 1558 yayın dahil edildi. Veriler, daha ileri analizlerde kullanılmak üzere VOSviewer yazılım programına aktarıldı.

Bulgular: En fazla çalışma yayınlayan ve çalışmalarına atf yapılan ülkeler arasında Amerika ve Çin'in ön planda olduğu görülmektedir. Atf sayısında Q1 dergilerinin ön planda olduğu ve çoğunlukla diş hekimliği tabanlı dergiler olduğu belirlenmiştir. Yazarlar ve kurumlar açısından sıralamalarda da Amerika ve Çin'in baskınlığı dikkat çekicidir. TMEOA çalışmalarında en sık görülen anahtar kelimeler sırasıyla "Disorders", "Cartilage", "Expression", "Pain", "Internal Derangement", "Articular-Cartilage", "Temporomandibular Disorders", "Chondrocyts", "Rheumatoid Arthritis", "Synovial Fluid" olarak kaydedilmiştir.

Sonuç: TMEOA üzerine bibliyometrik analiz yöntemini kullanan bir çalışma bulunmamaktadır. Web of Science tarafından indekslenen dergilerde yayınlanan TMEOA üzerine makalelerin araştırma verimliliğini VOSviewer aracılığıyla bibliyometrik analiz yöntemini kullanarak analiz ettik. Bu analizin gelecekte bu konu üzerinde çalışan araştırmacılara, kurum ve kuruluşlara yardımcı olacağını düşünüyoruz.

Anahtar Kelimeler: Bibliyometrik analiz, osteoartrit, temporomandibular eklem

Abstract

Objective: Temporomandibular joint osteoarthritis (TMJOA) is the most common subtype of temporomandibular disorders. This study aims to analyze the research productivity of articles on temporomandibular joint osteoarthritis published in journals indexed by the Web of Science, using a bibliometric analysis method.

Material and Methods: A systematic search was conducted in the Web of Science Core Collection database on June 9, 2024. A total of 1883 documents were identified in the search for TMJOA. Finally, after applying exclusion criteria, 1558 publications were included in this study. The data were transferred to VOSviewer software for further analysis.

Results: It is seen that the USA and China are at the forefront among the countries that publish the most documents and whose documents are cited. It has been determined that Q1 journals are at the forefront in terms of citations and are predominantly dentistry-based journals. The dominance of the USA and China in the rankings regarding authors and affiliation is also noticeable. The most frequently seen keywords in TMJOA studies are recorded as Disorders, Cartilage, Expression, Pain, Internal Derangement, Articular-Cartilage, Temporomandibular Disorders, Chondrocytes, Rheumatoid Arthritis, and Synovial Fluid, respectively.

Conclusion: There is no study using the bibliometric analysis method on TMJOA. We analyzed the research productivity of articles on TMJOA published in journals indexed by Web of Science using the bibliometric analysis method via VOSviewer. We think that this analysis will be helpful to researchers, institutions, and organizations working on this subject in the future.

Keywords: Bibliometric analysis, Osteoarthritis, Temporomandibular joint

Correspondence: Sema POLAT Cukurova University Faculty of Medicine, Department of Anatomy, Adana, Türkiye

Phone: +90 507 994 29 81 **e-mail:** sezaoz@hotmail.com

ORCID No (Respectively): 0000-0001-7330-4919, 0000-0003-1373-4700, 0000-0002-9689-9852, 0000-0002-0015-3010

Submission date: 01.08.2024

Acceptance date: 10.09.2024

DOI: 10.17517/ksutfd.1526176

INTRODUCTION

The temporomandibular joint (TMJ), one of the most important and complex joints in the body, plays a key role in breathing, speaking, chewing, and many other vital activities (1). The joint located between the condyle of the mandible and mandibular fossa is located at the junction of the temporal, cranial, and mandibular regions in the middle region of the head in the sagittal plane. TMJ has an articular disc composed of fibrous tissue. This disc does not contain vessels and nerve fibers. In addition, TMJ has three functional ligaments: the collateral ligament, capsular ligament, and temporomandibular ligament. There are depression, protrusion, and lateral movements of the mandible. Also, TMJ has rotation and translation movements. The muscles responsible for these movements are the temporal muscle, masseter muscle, lateral pterygoid muscle, medial pterygoid muscle, and digastric muscle. Defects in all these structures and movements can cause TMJ disorders (2). Temporomandibular joint disorders (TMDs) include certain problems that affect the TMJ from different aspects. As a result of these problems, pain and functional limitations occur. It is also a long-lasting orofacial pain condition that is challenging for work productivity, social interaction, and overall quality of life (3). All these problems are also valid in osteoarthritis, one of these disorders (4).

Temporomandibular joint osteoarthritis (TMJOA) is the most common subtype of temporomandibular disorders (TMD) (4). Temporomandibular joint osteoarthritis (TMJOA) is a multifactorial, chronic, progressive, degenerative disease that occurs in the TMJ region and causes significant pain and functional limitations (4-6). Factors that cause this condition are age, systemic disease, hormonal imbalances, malocclusion, and genetic disorders (7). The main symptoms of TMJOA are pain in the temporomandibular region, crunching, and abnormal mandibular movements (4). Unfortunately, there are few effective treatment strategies for TMJOA since its pathology and progression mechanism are not fully known (8). From this perspective, the main treatment principle of TMJOA is conservative treatment methods, including joint protection, physical therapy, occlusal splints, nonsteroidal anti-inflammatory drugs (NSAIDs), and glucosamine sulfate (4,6). Although current conservative treatment methods are considered ineffective in improving the chronic condition and long-term treatment of the disease, they may be effective in suppressing the symptoms of the disease. For this reason, it is very difficult to specify or constitute a gold standard in the treatment of TMJOA (4-6). For this reason, it is extremely necessary to develop new treatment strategies for TMJOA disease, and new studies are needed on this subject (6).

Articles from peer-reviewed journals are continually published, and a serious accumulation of knowledge and information is created. In addition, although there are systematic articles, there is also a need for studies that provide information about the identity and numerical quantities of the studies and serve as navigation within the network of studies (9). Bibliometric analysis, which functions as a map and navigation among the mass of articles, meets this need. Bibliometric analysis reveals a model that analyzes the literature to understand current approaches (10). First used in 1969, bibliometric analysis has become a science that includes bibliography, statistics, and mathematics (11). It's an approach that enables the quantitative assessment of productivity in any subject (12). With bibliometric analysis, detailed quantitative information can be learned about authors, keywords, journals, countries, institutions, citations, etc., in any research field (13). Visualization tools such as CiteSpace, Bibliometrix, and VOSviewer software (version 1.6.19, Leiden University, Netherlands) are used to reveal bibliometric analysis more clearly and make it accessible. In this way, various data in publications can be easily benefited from (1).

To date, there have been very few evaluations of research productivity in the field of temporomandibular joint osteoarthritis (14). Moreover, no studies have been conducted using bibliometric analysis on this subject. The null hypothesis is that the existing literature on the topic of TMJOA provides sufficient evidence. This study aims to analyze the research productivity of temporomandibular joint osteoarthritis articles published in journals indexed by Web of Science using the bibliometric analysis method via VOSviewer.

MATERIALS AND METHODS

A systematic search was conducted in the Web of Science Core Collection (WoSCC) database at 9 June 2024. First of all, according to the search method, which is (ALL=(Temporomandibular)) OR ALL=(Temporomandibular joint)) OR ALL=(Articulatio temporomandibularis), there were 25134 articles. Then, the following search terms were used: (ALL = (temporomandibular) AND ALL = (osteoarthritis)). A total of 1883 documents were identified in the search. Afterwards, the following inclusion-exclusion criteria were used. Indexes which is in the WoS Core Collection were included.

- Science Citation Index Expanded (SCIE)
- Emerging Sources Citation Index (ESCI)

Additionally, the following indexes were excluded: Book Citation Index (BKCI-S), Social Sciences Citation Index (SSCI), and Conference Proceedings Citation Index – Science. Only the original article was

included, while other document types such as review articles, meeting abstracts, early access, proceeding papers, letters, etc. were excluded. Furthermore, language restrictions are not used. Finally, 1558 publications were included in this study. All these documents were exported from the system for analysis with scientific mappings in the VOSviewer software program (version 1.6.19, Leiden University, Netherlands). All these documents were exported via 'tab delimited' (Windows) file format within 'full recorded and cited references' from 1 document to 1558 by dividing 500 documents. The exported data were transferred to the VOSviewer software program for analysis using bibliometric analysis

and scientific mapping methods. VOSviewer (version 1.6.19) software was used to perform bibliometric analyses. Annual publication numbers and annual citation numbers of publications in the field of temporomandibular joint and osteoarthritis between 1980 and 2024 were taken from Web of Science (WoS). VOSviewer was used to calculate the top 10 most prolific authors, institutions, journals, and countries and create co-occurrence or clustering maps for cited journals, institutions, and countries. Moreover, VOSviewer was used to create co-citation and clustering visualization maps for countries and keywords. All search strategies and the selection process are shown in **Figure 1**.

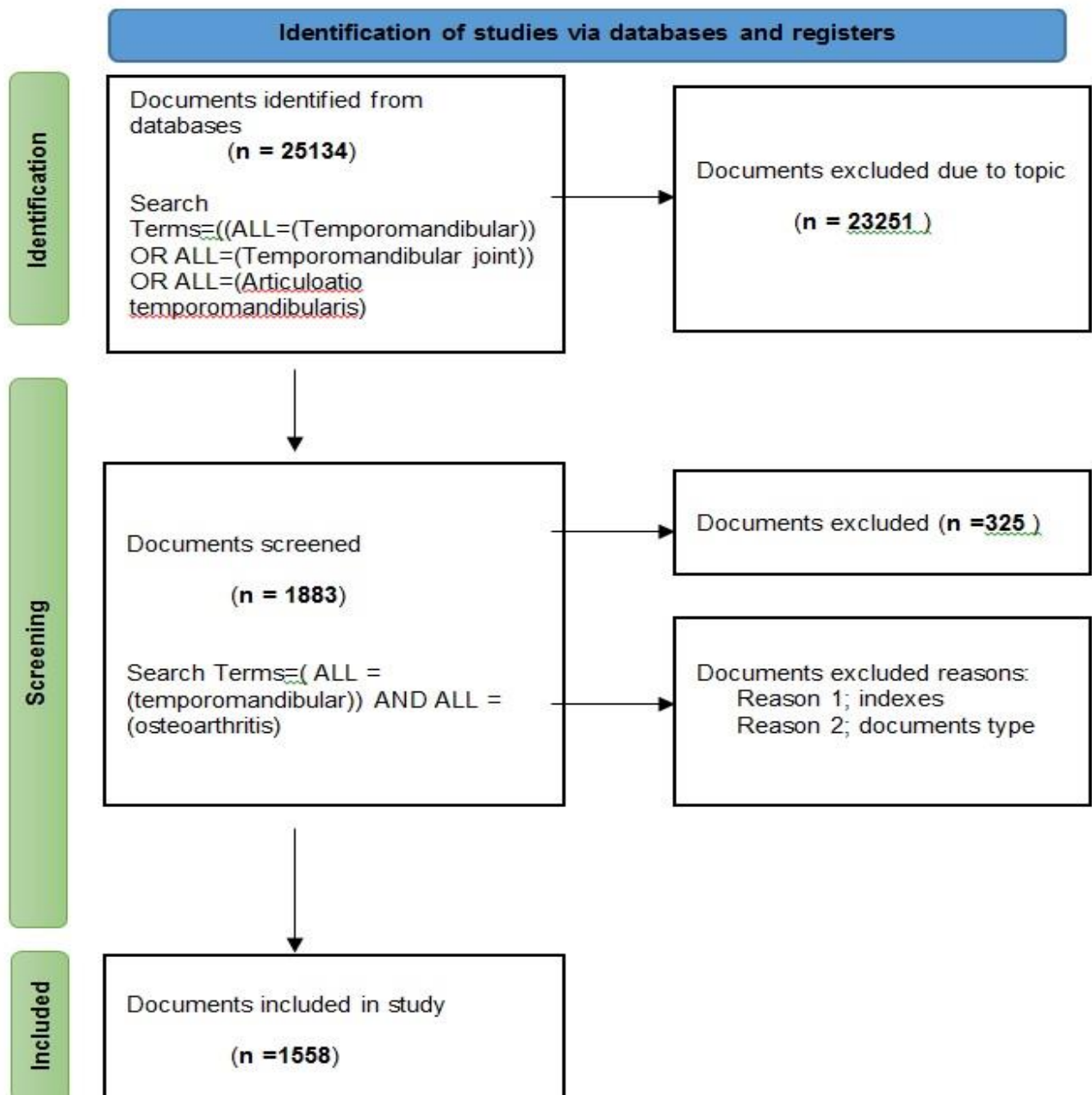


Figure 1. Search strategy and selection process

Ethics Statement

As the authors, we declare that due to the method of this study, ethics committee approval was not obtained, and no such requirement this.

RESULTS

In total, the current research captured 1558 original articles related to the temporomandibular joint and osteoarthritis in June 2024. The first document scanned

in WoS was in 1981. The number of documents has increased exponentially over the years. There was not much increase in the studies conducted between the 1980s and the early 2000s. Although there was a significant increase in the rate of studies in the early 2000s, the rate has been increasing more sharply since the 2010s (**Figure 2**).

Although the country with the most documents is China (25.67%), the country with the most citations is the United States (**Figure 3**).

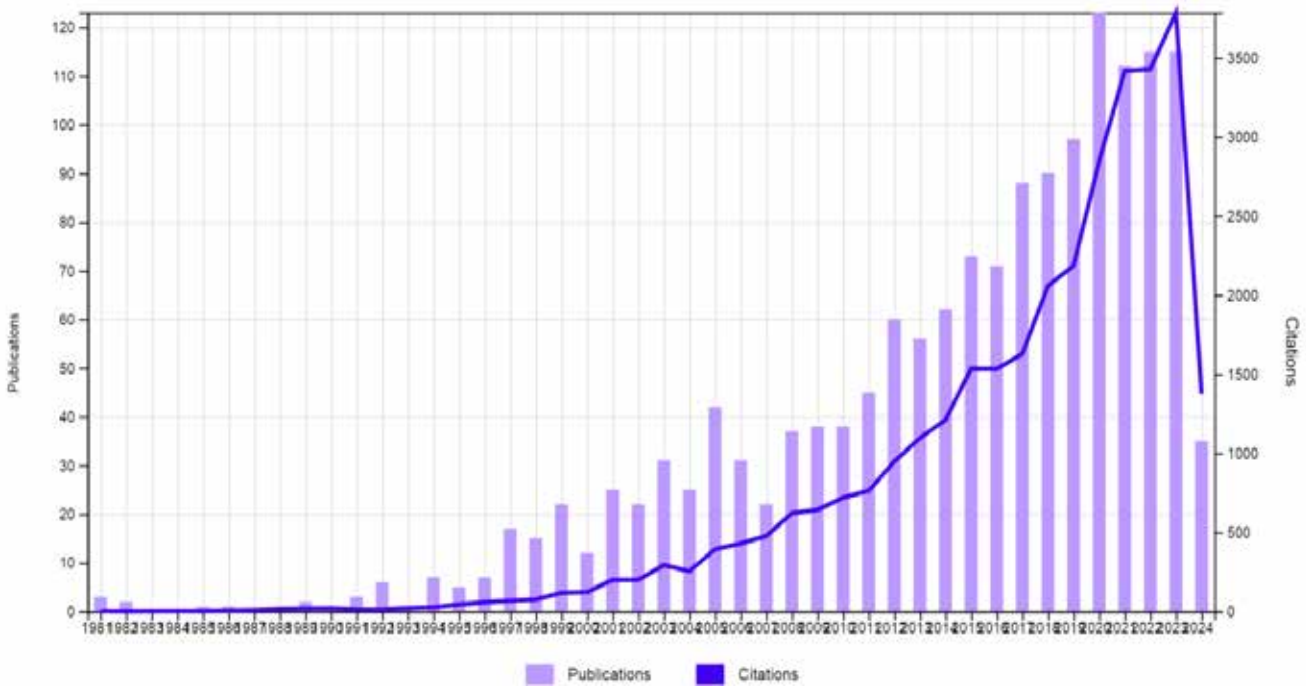


Figure 2. Publication and citation numbers by year

Countries

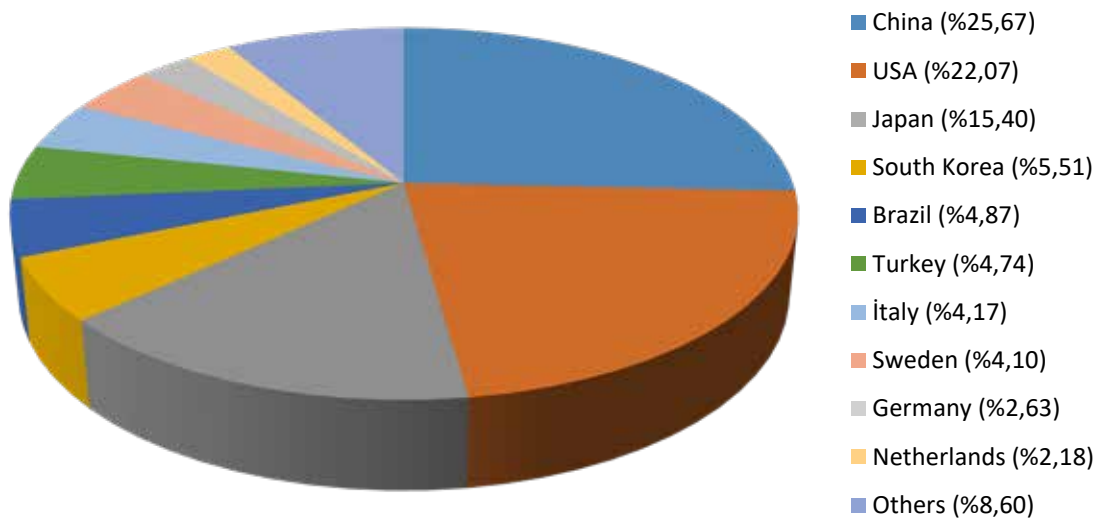


Figure 3. Percentage representation of countries with the most documents

These two countries stand out in terms of having the highest number of documents and the number of citations. These two countries are followed by Japan (Table 1).

According to the map of countries with the most documents made by Vosviewer in Figure 4, China, USA, and Japan are located in the center of the map, and the number of connections between each other is quite high. Fourth Military Medical University ranks first in the top 10 organizations with the most documents and the most citations (Figure 4).

While universities in China dominate among the 10 organizations with the most documents, universities in

the USA dominate among the 10 organizations with the most citations. It is seen that among the organizations in European countries, only the University of Padua in Italy is in the top 10 most cited organizations (Table 2).

Journal of Oral and Maxillofacial Surgery ranks first in the top 10 sources with the most documents and the top 10 sources with the most citations. The following sources include both top 10 lists: International Journal of Oral and Maxillofacial Surgery, Journal of Oral Rehabilitation, Osteoarthritis and Cartilage, Archives of Oral Biology, Journal of Dental Research and Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology and Endodontology (Table 3).

Table 1. Top 10 countries with most documents and citations

Rank	Country	Documents	Country	Citations
1	China	400	United State of America	10568
2	United State of America	344	China	6255
3	Japan	240	Japan	4698
4	South Korea	86	Sweden	2117
5	Brazil	76	Italy	1986
6	Turkey	74	South Korea	1301
7	Italy	65	Brazil	1256
8	Sweden	64	Turkey	1089
9	Germany	41	Canada	990
10	Netherlands	34	Germany	924

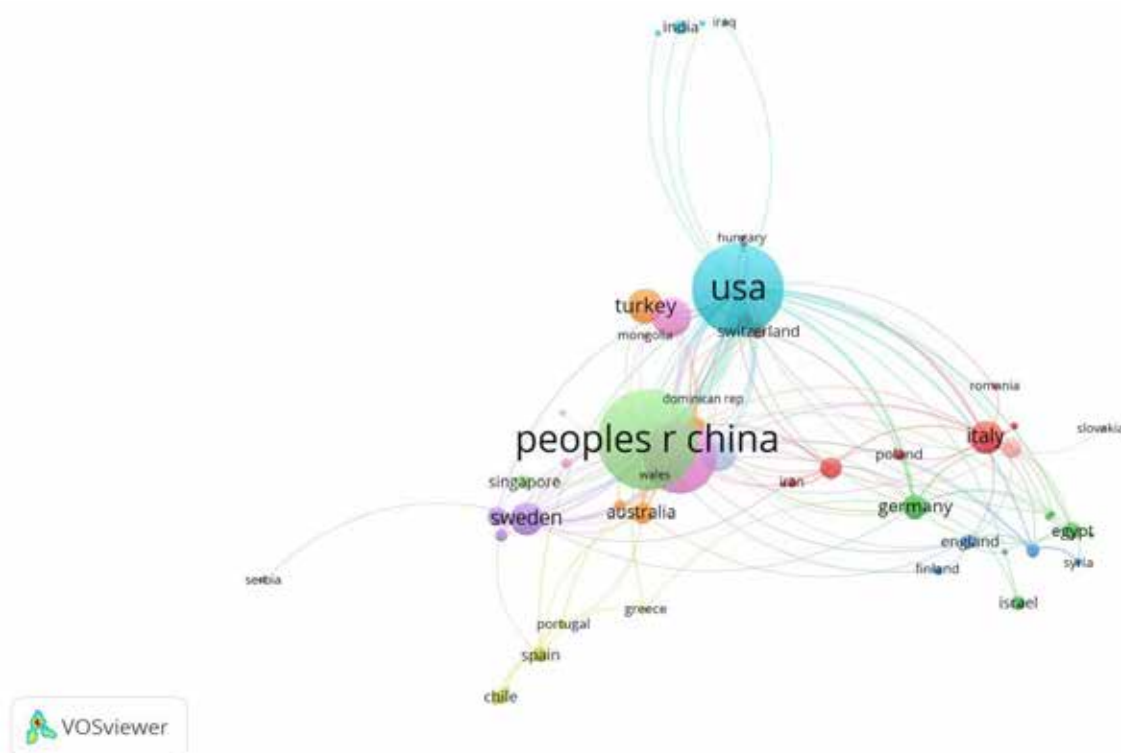


Figure 4. Countries' network map according to documents via VOSviewer software

Table 2. Top 10 organizations with most documents and citations

Rank	Organization	Documents	Organization	Citations
1	Fourth Military Medical University (China)	67	Fourth Military Medical University (China)	1625
2	Sichuan University (China)	64	University of Washington (USA)	1217
3	Wuhan University (China)	46	Sichuan University (China)	968
4	Shanghai Jiao Tong University (China)	37	University of Minnesota (USA)	931
5	Seoul National University (South Korea)	34	Rush University (USA)	915
6	Nihon University (Japan)	29	University of Padua (Italy)	844
7	Peking University (China)	26	Harvard University (USA)	768
8	Zhejiang University (China)	25	Columbia University (USA)	735
9	University of California Davis (USA)	24	Kanazawa Medical University (Japan)	685
10	Rush University (USA)	24	Seoul National University (South Korea)	652

Table 3. Top 10 sources with the most published documents and citations

Rank	Documents Number				Documents Citations			
	Source	Quartile	Country	Documents	Source	Quartile	Country	Citations
1	Journal of Oral and Maxillofacial Surgery	Q1	USA	98	Journal of Oral and Maxillofacial Surgery	Q1	USA	2923
2	International Journal of Oral and Maxillofacial Surgery	Q1	USA	64	Osteoarthritis and Cartilage	Q1	UK	1832
3	Journal of Oral Rehabilitation	Q1	UK	64	International Journal of Oral and Maxillofacial Surgery	Q1	USA	1545
4	Osteoarthritis and Cartilage	Q1	UK	55	Oral Surgery Oral Medicine Oral Pathology Oral Radiology and Endodontology	Q2	USA	1475
5	Journal of Cranio-Maxillofacial Surgery	Q2	USA	50	Journal of Oral Rehabilitation	Q1	UK	1312
6	Archives of Oral Biology	Q2	UK	47	Journal of Dental Research	Q1	USA	1282

7	Cranio the Journal of Cra- niomandibular & Sleep Prac- tice	Q2	UK	43	Journal of Orofa- cial Pain	Q3	USA	1132
8	Journal of Den- tal Resarch	Q1	USA	37	Archives of Oral Biology	Q2	UK	905
9	Oral Surgery Oral Medicine Oral Pathology Oral Radiology and Endodon- tology	Q2	USA	36	Pain	Q1	USA	864
10	Journal of Oral Pathology & Medicine	Q1	UK	34	Dentomaxillofaci- al Radiology	Q1	UK	860

Among the top 10 most cited documents, Ahmad et al.'s article titled 'Research diagnostic criteria for temporomandibular disorders (RDC/TMD): development of image analysis criteria and examiner reliability for image analysis' ranks first (**Table 4**) (15).

Four documents in Table 4 were published in the 90s, the rest in the 2000s (15-24). When looking at the 10 most repeated keywords, excluding 'osteoarthritis' and 'temporomandibular joint', 'disorders' comes first. This is followed by 'cartilage' and 'expression' (**Table 5**).

Looking at the map of the 100 most repeated keywords, excluding 'osteoarthritis' and 'temporomandibular joint', 4 clusters are seen. The blue cluster often includes keywords related to osteoarthritis treatment methods. The red cluster is mostly associated with changes in cartilage and TMJ. The green cluster is more related to disorders. The yellow cluster is mostly related to changes in synovial fluid and rheumatoid arthritis (**Figure 5**).

Among the top 10 authors with the most documents, Wang, Meiqing (48 documents) ranks first (**Table 6**).

Finally, looking at the Web of Science Categories, the 'Dentistry Oral Surgery Medicine' is clearly at the forefront (**Figure 6**).

DISCUSSION

A systematic search was conducted in the WoSCC database to determine the location of OA within the

TMJ on June 9, 2024. In this way, a prediction regarding OA's relationship with TMJ and its future can be provided from a general perspective. Also, it will be possible to determine what further study has been done and what study will be needed in the future. In the search conducted for this purpose, 25134 articles containing the terms 'Temporomandibular', 'Temporomandibular joint', 'Articulatio temporomandibularis' were found. Then, to narrow the scope of the study, the terms 'Temporomandibular' and 'Osteoarthritis' were used in the search. 1883 articles found. Filters mentioned in the method section were applied, and finally, 1558 articles were included in the scope of the study. These articles were processed in VOSViewer software for bibliometric analysis. Bibliometric analysis analyzes the literature to understand current publications (10). For this analysis, visualization tools such as VOSviewer software are used to reveal and visualize more clearly (1). No research has been conducted on OA and TMJ using the bibliometric analysis method. This study aims to analyze the research productivity of articles about OA and TMJ using bibliometric analysis. It seems that these publications are mostly published in China. We think one of the reasons for this situation is that TMJ/OA affects approximately 30% of the population in mainland China (4). However, it seems that the country most cited is the United States of America. Based on data published by the World Bank, the United Nations Economic Commission for Europe, and the Organization for Economic Co-operation and Development, per capita Research

Table 4. Top 10 most cited documents

Rank	Author	Article Title	Journal	Date	Citations
1	Ahmad M, Hollender L, Anderson Q, et al. ¹⁵	Research diagnostic criteria for temporomandibular disorders (RDC/TMD): development of image analysis criteria and examiner reliability for image analysis	Oral Surgery Oral Medicine Oral Pathology Oral Radiology and Endodontology	2009	418
2	Zhang S, Teo KYW, Chuah SJ, et al. ¹⁶	Msc Exosomes Alleviate Temporomandibular Joint Osteoarthritis by Attenuating Inflammation and Restoring Matrix Homeostasis	Biomaterials	2019	321
3	Kubota E, Kubota T, Matsumoto J, Shibata T, Murakami KI ¹⁷	Synovial Fluid Cytokines and Proteinases as Markers of Temporomandibular Joint Disease	Journal of Oral and Maxillofacial Surgery	1998	192
4	Alexiou K, Stamatakis HC, Tsiklakis K ¹⁸	Evaluation of the Severity of Temporomandibular Joint Osteoarthritic Changes Related to Age Using Cone Beam Computed Tomography	Dentomaxillofacial Radiology	2009	181
5	Kubota E, Imamura H, Kubota T, Shibata T, Murakami K ¹⁹	Interleukin 1 beta and stromelysin (MMP3) activity of synovial fluid as possible markers of osteoarthritis in the temporomandibular joint	Journal of Oral and Maxillofacial Surgery	1997	177
6	Yang H, Wen Y, Zhang M, et al. ²⁰	Mtorc1 Coordinates the Autophagy and Apoptosis Signaling in Articular Chondrocytes in Osteoarthritic Temporomandibular Joint	Autophagy	2020	167
7	Debont LGM, Boering G, Liem RSB, Eulerink F, Westesson PL ²¹	Osteoarthritis and Internal Derangement of the Temporomandibular – Joint – a Light Microscopic Study	Journal of Oral and Maxillofacial Surgery	1986	163
8	Yap AUJ, Tan KBC, Prosthodont C, Chua EK, Tan HH ²²	Depression and Somatization in Patients with Temporomandibular Disorders	Journal of Prosthetic Dentistry	2002	160
9	Ohrbach R, Dworkin SF ²³	Five – Years Outcomes in Tmd: Relationship of Changes in Pain to Changes in Physical and Psychological Variables	Pain	1998	155
10	Schiffman EL, Ohrbach R, True-love EL, et al. ²⁴	The Research Diagnostic Criteria for Temporomandibular Disorders. V: Methods Used to Establish and Validate	Journal of Orofacial Pain	2010	154

Table 6. Top 10 author with most published document

Rank	Author	Documents	H-Index
1	Wang, Meiqing	48	30
2	Long, Xing	35	22
3	Zhang, Mian	32	19
4	Manfredini, Daniele	24	52
5	Lu, L	22	25
6	Nardini, Luca Gu- arda	21	40
7	Segami, Natsuki	20	28
8	Yang, Hong-Xu	20	18
9	Jiao, Kailin	19	32
10	Liu, Qian	19	22





Figure 6. Viewing Web of Science Categories with Treemap Chart

& Development expenditures in the United States of America are 2113 dollars, while in China, it is 440 dollars in 2021 (25). It shows us the effect of the difference between expenses on the quality of publication. In addition, there are 5 organizations from the USA among the top 10 most cited organizations, and there are 6 sources from the USA among the top 10 most cited sources. This suggests to us that publications in the United States are of higher quality.

Considering the annual publication and citation number of 1558 articles, it is seen that there was a more significant increase for the first time at the end of the 90s. Additionally, there have been sharper increases since the early 2000s, especially after 2010. It is noticeable that there is a stagnation in the rate of the number of publications in the 2020s. We think that the COVID-19 Pandemic has been effective in this. However, we think that this stagnation is temporary because this topic is still interesting and needs new research. The most cited organization is the Fourth Military Medical University. This is because it is the organization with the most documents. Although the University of Washington is not among the top 10 organizations with the most documents, it is noteworthy that it ranks second among the top 10 most-cited organizations. This university published 64436 articles between 2018 and 2022. It was seen as a very active university academically. It also ranks 63rd in the QS World University Rankings in 2024 (26). Additionally, the University of Washington School of Medicine has 5 Nobel Prizes in Physiology or Medicine (27). We think that all of these have an impact on the number of citations. Considering the top

10 sources with the most publications, 5 of them are in the USA, and 5 of them are in the United Kingdom (28). These sources show us that they are very active on this issue. They will probably continue to be interested in this issue. Additionally, when we look at the top 10 most cited sources, 7 of them are in Q1, 2 are in Q2, and only one journal is in Q3 in 2023 (28). Accordingly, we think that the Q value of the source affects the impact value and several citations of the publication. The most cited study by Ahmad M et al., 'Research diagnostic criteria for temporomandibular disorders (RDC/TMD): development of image analysis criteria and examiner reliability for image analysis', published in Oral Surgery Oral Medicine Oral Pathology Oral Radiology and Endodontology in 2009 is the publication. The Research Diagnostic Criteria for Temporomandibular Disorders (RDC/TMD) is a widely used diagnostic method for TMD. This article aims to report image analysis criteria for the RDC/TMD Validation Project. Additionally, the researchers evaluated the inter-examiner reliability of radiologists in interpreting panoramic, MR, and CT images of the TMJ for osteoarthritis (OA) and MR images for disc displacement or effusion. Finally, they evaluated the criterion validity of panoramic radiography and MRI to evaluate bone tissue changes using CT. As a result, comprehensive image analysis criteria have been developed. It has been demonstrated that it can be used reliably for the evaluation of OA using CT and for disc location and effusion using MRI (15). In our opinion, the reason for the high number of citations of this publication is that diagnostic criteria in temporomandibular disorders need to be developed. Therefore,

researchers referred to this publication to learn and develop new diagnostic criteria. In addition, new diagnostic criteria need to be examined to develop new treatment methods. The second most cited document is the article by Zhang S et al. titled 'Msc Exosomes Alleviate Temporomandibular Joint Osteoarthritis by Attenuating Inflammation and Restoring Matrix Homeostasis'. The effectiveness of mesenchymal stem cell (MSC) treatments is increasingly based on paracrine secretion, especially exosomes. This study aimed to demonstrate the translational potential of a cell-free, ready-to-use exosome-based agent to treat TMJ pain and degeneration. MSC exosomes have been observed to lead to overall joint restoration and regeneration (16). This article appears to be a study on the treatment of TMJOA. We think that the number of citations is high because TMJ contributes to OA treatment strategies. The third most cited document is the article titled 'Synovial Fluid Cytokines and Proteinases as Markers of Temporomandibular Joint Disease' by Kubota E. et al. In this article, biochemical markers in synovial fluid were examined to detect intra-articular inflammation and early cartilage destruction in temporomandibular joint disease. It was thought that simultaneous increases in active forms of cytokines (IL-1 and IL-6) and matrix metalloproteinases may be potential catabolic markers of cartilage destruction in the TMJ (17). The reason why this article has a high number of citations is that although it was published in 1998, it biochemically reveals the changes in cartilage in TMJOA. This article made a significant contribution to the literature for its time. From this perspective, the top 10 most cited articles are generally related to the formation mechanism, diagnostic criteria, methods, and treatment strategies of TMJOA. This also affects the number of citations.

Keywords are very important for articles to be easily found when searched. In addition, its easy availability will increase the number of citations (29). Looking at the map of the first 100 most repeated keywords, the four clusters form a general perspective on osteoarthritis and the temporomandibular joint. TMJOA is a progressive, degenerative, and complex disease that exhibits various pathological changes. These pathological changes are an inflammatory response, ECM degeneration, abnormal cell biological behaviors, and abnormal angiogenesis in TMJ tissue. One pathological change is linked to others and affects each other, creating a vicious circle (4). The red cluster contains keywords related to these changes in cartilage and TMJ. Changes in these structures can cause TMJ disorders. TMDs create several problems that affect the TMJ in different ways. As a result of these problems, pain and functional limitations occur (3). Keywords in the green cluster are related to disorders and dysfunctions in the

TMJ. TMJ is a synovial joint and is therefore susceptible to disorders in the field of rheumatology. For example, bilateral, symmetric TMJ involvement is observed in rheumatoid arthritis (RA) patients (30). The yellow cluster keywords is also related to synovial fluid and rheumatic disorders, especially rheumatoid arthritis. Treatment of temporomandibular joint osteoarthritis aims to relieve or reduce pain, restore normal mandibular movements, and improve the quality of life of patients. For this purpose, conservative treatment such as patient education, analgesics, splint therapy, physiotherapy, etc., less invasive surgical procedures such as intra-articular injections, arthrocentesis, arthroscopy, etc., and surgical procedures such as minimally invasive arthroscopic procedures, open joint surgeries, etc. can be applied (31). Finally, keywords in the blue cluster are related to these treatment methods and process management. In the scientific mapping method created by the VOSviewer program, keywords such as "pain", "disorder", "expression", and "cartilage" are shown in the center and with large circles indicate that studies are formed around these keywords and that these keywords are frequently found. However, keywords such as "tumor-necrosis-factor", "tgf-beta", "hyaluronic acid" expressed far from the center and with small circles indicate that these keywords have recently entered the literature or indicate studies that have been studied less, have little meaningful relationship and are far from the subject. New studies on these distant keywords can be considered by researchers. In this way, a different perspective can be presented and new areas of study can be discovered. Looking at the authors using these keywords, Meiqing Wang is the author with the most publications. He works at the Air Force Military Medical University School of Stomatology. He publishes in the fields of Dentistry, Oral Surgery & Medicine, Cell Biology, Orthopedics, Rheumatology, Biochemistry & Molecular Biology. He has a total of 120 publications registered in WOS (32). He is an active author who has produced numerous publications in different fields. The most cited publication of his publications included in the analysis is titled 'MTORC1 coordinates the autophagy and apoptosis signaling in articular chondrocytes in osteoarthritic temporomandibular joint' (20). This publication has been cited 167 times. It ranks sixth among the most cited publications. Although the author has the most documents does not mean anything in terms of quality; the fact that his most cited publication is among the top 10 most cited publications shows that the quality of his publications is good. On the other hand, one of the authors who deserves attention is Daniele Manfredini. He works at the University of Padua. He publishes in the fields of Dentistry, Oral Surgery & Medicine General & Internal Medicine, Neurosciences

es & Neurology, Surgery Mathematics. He has a total of 278 publications registered in WOS (33). The most cited publication of his publications included in the analysis is titled 'Age peaks of different RDC/TMD diagnoses in a patient population' (34). This publication has been cited 123 times. The most important feature of this author is that his H-Index is 52. He is the author with the highest H-index among the authors with the most documents. The H-index measures the cumulative academic impact of the author's performance. It is a reliable and solid measure of academic success (35). In conclusion, among WOS Categories, Dentistry Oral Surgery Medicine is at the forefront. Among the top 10 most cited documents, 7 (1st, 3rd, 4th, 5th, 7th, 8th, 10th) are in this category. Also, the top 10 authors with the most documents all have publications in this category. Since TMJ is very closely related to the structures that dentists deal with, it can be considered normal for this category to be at the forefront.

This study has several limitations. First, all the literature was collected from WOSCC only. Studies in other databases were not included. A more comprehensive bibliometric analysis needs to be conducted. Second, due to VOSviewer's software limitations, self-citations could not be excluded. Additionally, other bibliometric software programs such as CiteSpace or Bibliometrix were not used, which would have been helpful for detailed analysis. Third, search strategies can be chosen differently, and this issue can be analyzed from different aspects. Finally, there is a possibility that the study may be out of date, as some newly published articles may have been omitted due to delay.

When the data of the study is examined holistically, it is seen that new areas of study have emerged on the subject of TMJ OA from the keyword maps. Although it is seen that the field of dentistry is more focused on this subject, it can be seen that an interdisciplinary approach will reveal new areas of study on the current subject. We believe that rheumatologists and physiologists should focus more on this field. While it is seen in the study that only certain countries, such as the USA and China, are focused on this field, we recommend that other developing countries also take the opportunity and focus on this field, which has dark spots that have not yet been discovered. We believe that the fact that only Chinese researchers are at the forefront in this field means that the field is still open to development and that different researchers from different fields with interdisciplinary and multidisciplinary approaches will bring different perspectives to the field. We see that our

null hypothesis is falsified because it has been revealed that there is still a need for studies in the field, and this need is seen in the keyword maps. Although the intensification of studies in recent years can of course be explained by developing technology, it also shows that the field has only just emerged. The fact that among the most cited studies were studies published in 2019 and 2020 supports this view.

Conclusively, there is no study using the bibliometric analysis method on TMJOA, whereas there are many studies about TMJ. We analyzed the research productivity of articles on TMJOA published in journals indexed by Web of Science using the bibliometric analysis method via VOSviewer. Today, interest in the diagnosis and treatment of this subject continues. Because of this interest, we think that this analysis will be helpful to researchers, institutions, and organizations working on this subject in the future. With this analysis, we added to the literature, and we aim to provide them with new perspectives on this subject. They will also focus on the missing parts of the subject from this perspective.

Statements and Declarations

Ethics Statement: As the authors, we declare that due to the method of this study, ethics committee approval was not obtained, and no such requirement this.

Funding: No funds, grants, or other support were received.

Data availability: The supply of raw data is available upon request.

Conflict of interest: The authors declare no conflicts of interest.

External editing/writing: None

Financial interests: The authors declare they have no financial interests.

Author Contribution

S.P.: Conceptualization, Data Curation, Formal Analysis, Project Administration, Writing – Original Draft Preparation, Supervision, Writing – Review & Editing, Supervision. M.T.: Data Curation, Formal Analysis, Writing – Original Draft Preparation, Validation, Methodology, Investigation. U.A.: Data Curation, Formal Analysis, Writing – Original Draft Preparation, Validation, Methodology, Investigation. P.G.: Writing – Review & Editing, Supervision, Project Administration, Visualization

REFERENCES

- Xiong X, Gao X, Zhong J, Hu S, Li Y, Zheng Y, et al. Bibliometric Analysis of Research on Temporomandibular Joint and Occlusion from 2000 to 2022. *J Pain Res.* 2023;16:2847-2860.
- Iturriaga V, Bornhardt T, Velasquez N. Temporomandibular Joint: Review of Anatomy and Clinical Implications. *Dent Clin North Am.* 2023;67:199-209.
- Taqi M, Zaidi SJA, Siddiqui SU, Zia B, Khadija Siddiqui M. Dental practitioners' knowledge, management practices, and attitudes toward collaboration in the treatment of temporomandibular joint disorders: a mixed-methods study. *BMC Prim Care.* 2024;25:137.
- Juan Z, Xing-Tong M, Xu Z, Chang-Yi L. Potential pathological and molecular mechanisms of temporomandibular joint osteoarthritis. *J Dent Sci.* 2023;18:959-971.
- Jia XY, Jing SL, Sun Y, Gong ZC, Guo ZC. A randomized controlled clinical trial of concentrated growth factor combined with sodium hyaluronate in the treatment of temporomandibular joint osteoarthritis. *BMC Oral Health.* 2024;24:540.
- Tuerxun P, Ng T, Zhao K, Zhu P. Integration of metabolomics and transcriptomics provides insights into the molecular mechanism of temporomandibular joint osteoarthritis. *PLoS One.* 2024;19:e0301341.
- Liu Q, Zhao Y, Shi H, Xiang D, Wu C, Song L, et al. Long-term haploinsufficiency of DSPP causes temporomandibular joint osteoarthritis in mice. *BMC Oral Health.* 2024;24:569.
- Pang C, Zhang H, Liu Y, Tang N, Tian K, Mu Y, et al. Glutathione peroxidase 4 restrains temporomandibular joint osteoarthritis progression by inhibiting ferroptosis. *J Cell Mol Med.* 2024;28(9):e18377.
- Ioannidis JP, Boyack KW, Klavans R. Estimates of the continuously publishing core in the scientific workforce. *PLoS One.* 2014;9(7):e101698.
- Bahşi İ, Adanır SS, Kervancıoğlu P, Orhan M, Govsa F. Bibliometric Analysis of Turkey's Research Activity in the Anatomy and Morphology Category from the Web of Science Database. *Eur J Ther.* 2021;27:268-280.
- Akmal M, Hasnain N, Rehan A, Iqbal U, Hashmi S, Fatima K, et al. Glioblastoma Multiforme: A Bibliometric Analysis. *World Neurosurg.* 2020;136:270-282.
- Ge Y, Chao T, Sun J, Liu W, Chen Y, Wang C. Frontiers and Hotspots Evolution in Psycho-cardiology: A Bibliometric Analysis From 2004 to 2022. *Curr Probl Cardiol.* 2022;47:101361.
- Wu F, Gao J, Kang J, Wang X, Niu Q, Liu J, et al. Knowledge Mapping of Exosomes in Autoimmune Diseases: A Bibliometric Analysis (2002-2021). *Front Immunol.* 2022;13:939433.
- Wang Q, Jia J, Zhou C, Ye W, Bi R. A Bibliometric Analysis of Research on Temporomandibular Joint Disc Displacement from 1992 to 2022. *Healthcare (Basel).* 2023;11(14):2108.
- Ahmad M, Hollender L, Anderson Q, Kartha K, Ohrbach R, Truelove EL, et al. Research diagnostic criteria for temporomandibular disorders (RDC/TMD): development of image analysis criteria and examiner reliability for image analysis. *Oral Surg Oral Med Oral Pathol Oral Radiol Endo.* 2009;107:844-860.
- Zhang S, Teo KYW, Chuah SJ, Lai RC, Lim SK, Toh WS. MSC exosomes alleviate temporomandibular joint osteoarthritis by attenuating inflammation and restoring matrix homeostasis. *Biomaterials.* 2009;200:35-47.
- Kubota E, Kubota T, Matsumoto J, Shibata T, Murakami KI. Synovial fluid cytokines and proteinases as markers of temporomandibular joint disease. *J Oral Maxillofac Surg.* 1998;56:192-198.
- Alexiou K, Stamatakis H, Tsiklakis K. Evaluation of the severity of temporomandibular joint osteoarthritic changes related to age using cone beam computed tomography. *Dentomaxillofac Radiol.* 2009;38:141-147.
- Kubota E, Imamura H, Kubota T, Shibata T, Murakami K. Interleukin 1 beta and stromelysin (MMP3) activity of synovial fluid as possible markers of osteoarthritis in the temporomandibular joint. *J Oral Maxillofac Surg.* 1997;55:20-28.
- Yang H, Wen Y, Zhang M, Liu Q, Zhang H, Zhang J, et al. MTORC1 coordinates the autophagy and apoptosis signaling in articular chondrocytes in osteoarthritic temporomandibular joints. *Autophagy.* 2020;16:271-288.
- de Bont LG, Boering G, Liem RS, Eulerink F, Westesson PL. Osteoarthritis and internal derangement of the temporomandibular joint: a light microscopic study. *J Oral Maxillofac Surg.* 1986;44:634-643.
- Yap AU, Tan KB, Chua EK, Tan HH. Depression and somatization in patients with temporomandibular disorders. *J Prosthet Dent.* 2002;88:479-484.
- Ohrbach R, Dworkin SF. Five-year outcomes in TMD: relationship of changes in pain to changes in physical and psychological variables. *Pain.* 1998;74:315-326.
- Schiffman EL, Ohrbach R, Truelove EL, Tai F, Anderson GC, Pan W, et al. The Research Diagnostic Criteria for Temporomandibular Disorders. V: Methods used to establish and validate revised Axis I diagnostic algorithms. *J Orofac Pain.* 2010;24:63-78.
- OECD (2024). Gross domestic spending on R&D (indicator). doi: 10.1787/d8b068b4-en (Accessed on 28 June 2024)
- About University of Washington. Available at: <https://www.topuniversities.com/universities/university-washington>
- About the University of Washington School of Medicine. Available at: <https://www.uwmedicine.org/school-of-medicine> (Date accessed: July 5, 2024)
- SCImago (n.d.). SJR — SCImago Journal & Country Rank (Portal). Available at: <http://www.scimagojr.com> (Date accessed: July 5, 2024)
- Corrin L, Thompson K, Hwang GJ, Lodge JM. The importance of choosing the right keywords for educational technology publications. *Australasian Journal of Educational Technology.* 2022;38:1-8.
- Covert L, Mater HV, Hechler BL. Comprehensive Management of Rheumatic Diseases Affecting the Temporomandibular Joint. *Diagnostics (Basel).* 2021;11:409.
- Derwich M, Mitus-Kenig M, Pawlowska E. Interdisciplinary Approach to the Temporomandibular Joint Osteoarthritis-Review of the Literature. *Medicina (Kaunas).* 2020;56:225.
- Author Profile. Available at: <https://www.webofscience.com/wos/author/record/39306115> (Date accessed: July 5, 2024)
- Author Profile Available at: <https://www.webofscience.com/wos/author/record/1130167> (Date accessed: July 5, 2024)
- Manfredini D, Piccotti F, Ferronato G, Guarda-Nardini L. Age peaks of different RDC/TMD diagnoses in a patient population. *J Dent.* 2010;38:392-399.
- Shah FA, Jawaid SA. The h-Index: An Indicator of Research and Publication Output. *Pak J Med Sci.* 2023;39:315-316.