ORIGINAL RESEARCH ORİJİNAL ARAŞTIRMA

DOI: 10.5336/dentalsci.2024-105200

Bibliometric Analysis of Articles on Exercise in Temporomandibular Joint Dysfunction

Temporomandibular Eklem Disfonksiyonunda Egzersiz ile İlgili Makalelerin Bibliyometrik İncelenmesi

Elif Esra ÖZMEN[a], Bayram Sönmez ÜNÜVAR[b]

[a]Karamanoğlu Mehmetbey University Ahmet Keleşoğlu Faculty of Dentistry, Department of Oral and Maxillofacial Surgery, Karaman, Türkiye
[b]KTO Karatay University Faculty of Health Sciences, Department of Audiology, Konya, Türkiye

ABSTRACT Objective: The aim of this study is to examine articles related to exercise in Temporomandibular Joint Dysfunction (TMD) using bibliometric analysis. **Material and Methods:** The research covers relevant studies published in the Web of Science database between 1982-2024. A search was conducted using the parameters for bibliometric analysis [title: ("Temporomandibular Joint Disorder" and "Exercise")], and a total of 147 studies were examined. The data were analyzed using the "bibliometrix 3.0" package and its web interface "biblioshiny" developed in the R programming environment. Annual scientific production, article types, most prolific authors, keyword occurrences, top research institutions, most prolific journals, most prolific countries and most cited articles were evaluated. **Results:** The analysis results indicate a consistent increase in studies on exercise applications for TMD over the years, with an annual growth rate of 2.65%. The Journal of Oral Rehabilitation was identified as the most prolific journal in this field, with Fialka-Moser, Nicolakis, and Erdoğmuş being the most productive authors. Vienna University emerged as the leading institution in terms of publication volume, and USA was found to be the country with the highest number of publications. Keyword analysis revealed that the terms exercise, "dysfunction", and "management" were the most frequently used. **Conclusion:** Exercise methods in the treatment of TMD hold a significant place in the scientific literature, and research in this area continues to grow. Future studies should examine in TMD treatment the effectiveness of exercise methods in more detail and evaluate their applicability to different patient groups. Additionally, increasing international collaborations and expanding scientific networks will enhance the quality and impact of research on TMD and exercise therapies.

Keywords: Bibliometrics; exercise; temporomandibular joint dysfunction

ÖZET Amaç: Bu çalışmanın amacı, Temporomandibular Eklem Disfonksiyonunda (TMD) egzersiz ile ilgili makalelerin bibliyometrik analiz yöntemiyle incelemektir. **Gereç ve Yöntemler:** Araştırma, 1982-2024 yılları arasında Web of Science veri tabanında yayımlanan ilgili çalışmaları kapsamaktadır. Bibliyometrik analiz için [başlık: ("Temporomandibular Eklem Bozukluğu" ve "Egzersiz")] parametreleri kullanılarak arama yapılmış ve toplamda 147 çalışma incelenmiştir. Veriler, R programı kullanılarak geliştirilen "bibliometrix 3.0" ve "biblioshiny" web arayüzü aracılığıyla analiz edilmiştir. Yıllık bilimsel üretim, makale türleri, en üretken yazarlar, anahtar kelime oluşumları, en iyi araştırma kurumları, en üretken dergiler, en üretken ülkeler ve en çok alıntı yapılan makaleler değerlendirildi. **Bulgular:** Analiz sonuçları, TMD için egzersiz uygulamaları üzerine yapılan çalışmaların yıllar içinde istikrarlı bir şekilde arttığını ve yıllık büyüme oranının %2,65 olduğunu göstermektedir. Journal of Oral Rehabilitation, bu alanda en çok yayına sahip dergi olarak belirlenmiş, Fialka-Moser, Nicolakis ve Erdoğmuş en üretken yazarlar arasında öne çıkmıştır. Viyana Üniversitesi en fazla yayına sahip üniversite olarak dikkat çekmiş ve ABD, bu alanda en fazla yayına sahip ülke olarak belirlenmiştir. Anahtar kelime analizinde egzersiz, "disfonksiyon" ve "yönetim" terimleri öne çıkmıştır. **Sonuç:** TMD tedavisinde egzersiz yöntemlerinin bilimsel literatürde önemli bir yer tuttuğu ve bu alandaki çalışmaların artarak devam ettiği görülmektedir. Gelecekteki araştırmaların, TMD tedavisinde egzersiz yöntemlerinin etkinliğini daha ayrıntılı bir şekilde incelemesi ve farklı hasta gruplarında uygulanabilirliğini değerlendirmesi önerilmektedir. Ayrıca, uluslararası iş birliklerinin artırılması ve bilimsel ağların genişletilmesi, TMD ve egzersiz tedavileri üzerine yapılan araştırmaların kalitesini ve etkisini artıracaktır.

Anahtar Kelimeler: Bibliometrics; egzersiz; temporomandibular eklem disfonksiyonu

TO CITE THIS ARTICLE:
Özmen EE, Ünüvar BS. Bibliometric analysis of articles on exercise in temporomandibular joint dysfunction. Turkiye Klinikleri J Dental Sci. 2025;31(2):165-72.

Correspondence: Bayram Sönmez ÜNÜVAR
KTO Karatay University Faculty of Health Sciences, Department of Audiology, Konya, Türkiye
E-mail: sonmezunuvar@gmail.com

Peer review under responsibility of Turkiye Klinikleri Journal of Dental Sciences.

Received: 20 Aug 2024 ***Received in revised form:*** 25 Sep 2024 ***Accepted:*** 20 Jan 2025 ***Available online:*** 21 Apr 2025

Temporomandibular joint dysfunction (TMD) is a complex clinical condition that arises from imbalances or disorders in the muscles and joints controlling jaw movements. TMD can manifest through symptoms such as pain, restricted jaw movement, clicking sounds, and difficulty chewing. This condition adversely affects both the functionality and quality of life of patients, necessitating various treatment approaches.[1]

In addition to surgical and pharmacological interventions, conservative treatment methods play a crucial role in managing TMD. Among these conservative methods, exercise therapy is often preferred as an initial treatment option due to its noninvasive nature and low cost.[2] Exercises aim to strengthen jaw muscles, enhance joint mobility, and reduce pain. Regular exercises can also ensure joint stability and prevent recurring symptoms.[3]

Research on the effectiveness of exercise applications for TMD indicates that this treatment method effectively alleviates symptoms and improves jaw functions. However, a comprehensive review of the literature is essential to determine the effectiveness and application protocols of these exercises.[4] In this context, studies using bibliometric analysis methods provide a thorough evaluation of scientific studies on TMD and exercise applications.

Bibliometric analysis is a method that evaluates the overall status of a research field using data such as keywords, classification codes, authors, and citations.[5] With the rapid advancement of technology and the increased use of computers, interest in studies utilizing this type of analysis has been growing.[6] This analysis evaluates studies in any academic field based on various parameters (subject, year, keywords, number of authors, citations, etc.), providing findings related to their scientific status. The data obtained offer valuable insights for evaluating the current state, identifying issues, and addressing problems in any discipline or scientific field.[7]

Bibliometrics was 1st defined by Allan Pritchard in 1969 in his work "Statistical Bibliography or Bibliometrics", where he described it as the application of mathematical and statistical methods to books and other communication media.[8] About 10 years later, Aiyepeku and Ehikhamenor expanded this definition, focusing on the characteristics of formulated information transfer to assess the progression and development of a discipline through the analysis of books, journal articles, and other graphic communication tools.[8] Conducting an in-depth bibliometric analysis of the literature on a specific topic can provide valuable information for future studies.[9] The accessibility of extensive bibliometric data from scientific databases such as Scopus and Web of Science (WoS), combined with the practical analytical capabilities of bibliometric software like Gephi (GNU General Public License, Common Development and Distribution License, France), Leximancer, and VOSviewer (Leiden, Holland), has heightened interest in these studies.[10]

This article presents the results of a bibliometric analysis conducted to determine the place and importance of exercise applications in the scientific literature on TDM.

MATERIAL AND METHODS

This research was conducted as a descriptive study by analyzing the selected database using document analysis methods. The study was conducted in accordance with the principles of the Declaration of Helsinki. To ensure access to the highest quality data relevant to the research topic, a globally recognized database containing high-quality academic articles was selected. Consequently, the data for this study were obtained from the WoS Core Collection database. This comprehensive search yielded a total of 147 articles, which were then subjected to detailed bibliometric analysis.

ETHICAL APPROVAL

Since the data were obtained from the WoS database, ethical committee approval was not required.

INFORMED CONSENT

Informed consent was obtained from all patients for being included in the study.

DATA ANALYSIS

The data were analyzed using the mapping and visualization software VOSviewer and MS Excel (Microsoft, USA). After selecting the database, it was necessary to filter and refine the relevant articles. For

accurate and reliable data analysis, a search was conducted in the WoS database using the parameters [title: ("Temporomandibular Joint Dysfunction") and title: ("Exercise") Timespan: 1982-2024 indexes: Science Citation Index-Expanded, Social Sciences Citation Index]. This search identified effective articles on the bibliometric analysis of exercise methods in treating temporomandibular joint dysfunction. The access date to the database was recorded as July 14, 2024. After filtering, the bibliometric analysis of the identified articles was conducted. At this stage, content analysis was performed using the "bibliometrix 3.0 (GNU General Public License, New Zealand)" program developed in the R environment and its web interface "biblioshiny (GNU General Public License, New Zealand)".[11] The following analyses were performed:

Annual Scientific Production: The number of articles published each year was plotted to identify trends in publication over time.

Article Types and Counts: Articles were categorized into original research articles, review articles, case reports, and editorials to determine the distribution of publication types.

Most Prolific Authors: The analysis of authorship focused on identifying the researchers who have contributed the most to the literature on exercise methods for TMD.

Keyword Analysis: Keywords associated with the articles were analyzed to identify the primary themes and areas of focus in the literature.

Institutional Contributions: The institutions that contributed to the research were identified and ranked based on the number of articles published.

Journal Analysis: Journals that published articles on TMD exercise methods were examined to determine the most prolific platforms for disseminating research findings.

Geographical Distribution: The distribution of publications across different countries was analyzed to identify the most active regions in TMD research.

Citation Analysis: The most cited articles were identified to assess their impact and influence on the field.

RESULTS

The bibliometric analysis included a total of 147 articles related to exercise methods in TMD. The years with the highest number of publications were identified as 2022 with 19 articles, 2023 with 14 articles, and both 2020-2021 with 13 articles each. This trend indicates a growing interest in the field over recent years (Figure 1). The distribution of article types showed that original research articles were the most

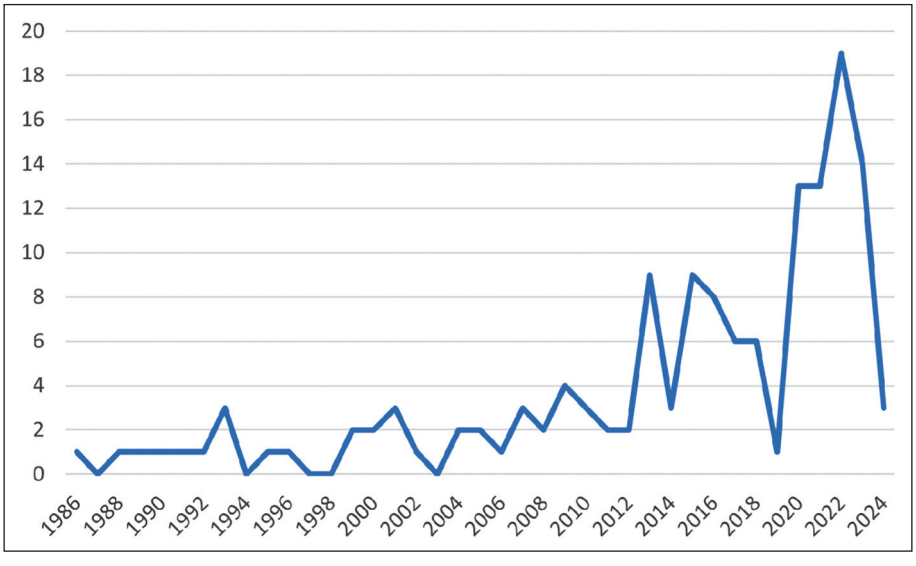

FIGURE 1: Annual scientific production

common, accounting for 114 publications, followed by 28 review articles, and 5 others. The predominance of original research articles suggests a strong focus on primary data collection and experimental studies in this field. Among the authors, the most prolific are Fialka-Moser and Nicolakis, each with 5 articles, followed by Erdoğmuş and Kopf, each with 4 articles (Figure 2). These authors have significantly influenced the research landscape in exercise methods for TMD treatment.

The analysis of keyword occurrences identified "exercise" with 40 occurrences, "dysfunction" and "management" each with 31 occurrences, while "disorders" with 28 occurrences and "pain" with 27 occurrences were identified (Figure 3). These keywords highlight the central themes and focal points of research in this area.

The top centers for research publications included Vienna University with 13 articles, Ravi Nair Physiotherapy College with 8 articles, Granada University with 7 articles, and Hacettepe University with 3 articles (Figure 4). These institutions have made significant contributions to the field of TMD and exercise methods. The most prolific journals have been identified as the Journal of Oral Rehabilitation and CRANIO: The Journal of Craniomandibular&Sleep Practice, each with 10 articles, followed by the Journal of Bodywork and Movement Therapies with 5 articles, and the Cureus Journal of Medical Science with 4 articles (Figure 5). These journals serve as key platforms for disseminating research findings in this area.

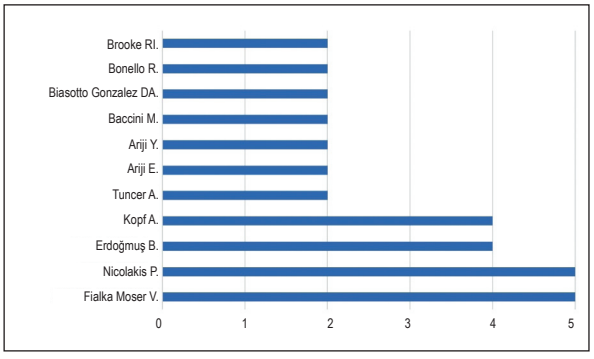

FIGURE 2: Most prolific authors

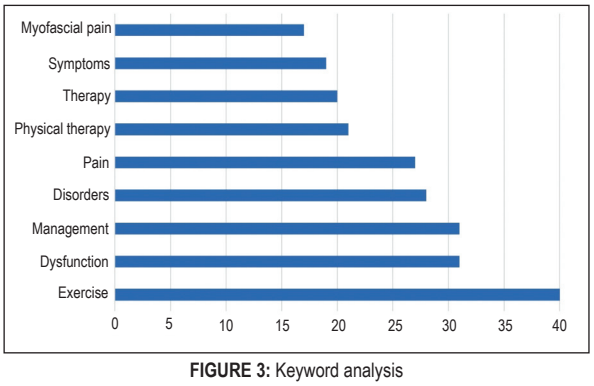

FIGURE 3: Keyword analysis

The most prolific countries have been identified as the USA with 20 articles, Brazil with 18 articles, India with 11 articles, Italy with 10 articles, and Türkiye with 6 articles (Figure 6).

The most highly cited articles include the studies by Medlicott and Harris with 179 citations, Hlaw-

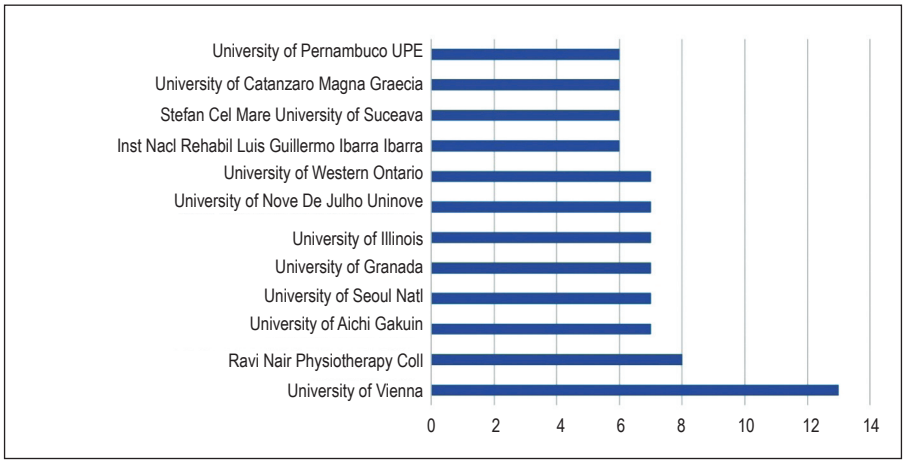

FIGURE 4: Institutional contributions

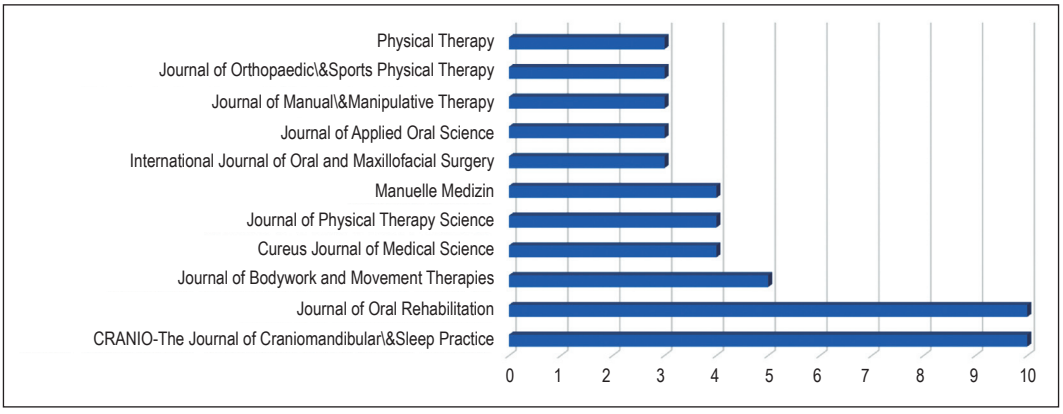

FIGURE 5: Journal analysis

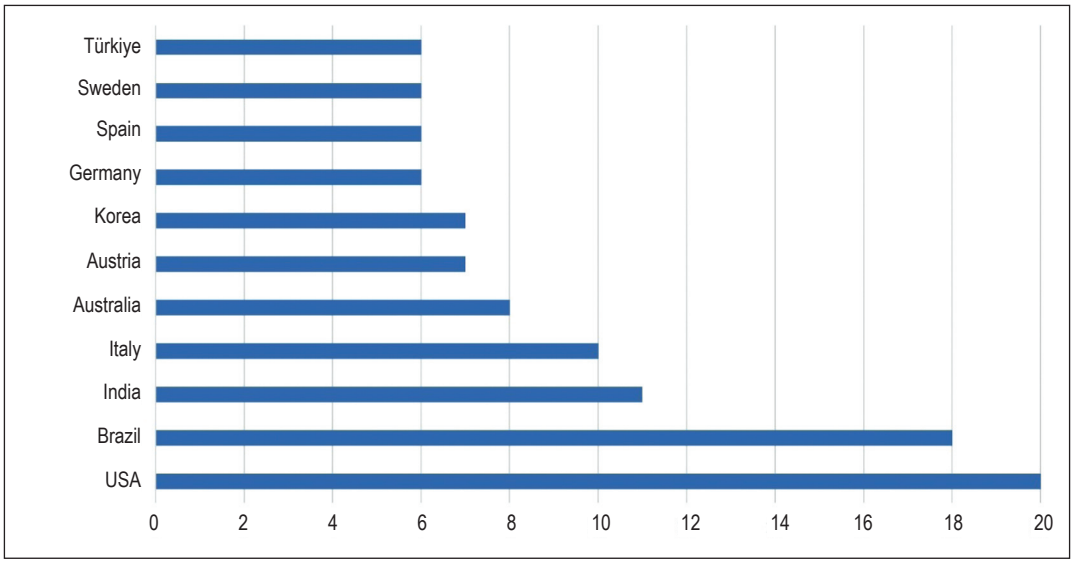

FIGURE 6: Geographical distribution

itschka, et al. with 116 citations, and Widmark G et al. with 92 citations.[12-14]

DISCUSSION

The bibliometric analysis of exercise methods for TMD reveals significant trends and patterns, underscoring the growing interest and scholarly activity in this field. The increase in publications from 2020 to 2023, with a peak in 2022, reflects a rising focus on TMD and exercise interventions. This growth trend highlights the increasing recognition of the importance of noninvasive treatment modalities for TMD.

Bibliometric analyses are powerful tools for understanding how scientific literature in a particular field has developed. These analyses allow us to determine the distribution of publications over time, the most influential authors, the most frequently used keywords, and the most cited studies. This provides a better understanding of the current state and trends in the research area.[12] In the literature, the study titled "Bibliometric Analysis of Telemedicine and e-Health Literature" aimed to investigate the past patterns of telemedicine and e-health research over the past 10 years. The database used was Scopus. The research was conducted on 1,401 articles to determine the most cited authors, journals, institutions,

countries, and the most cited articles. The findings of the research reflect the growth trend of publications, the model of authors, and the distribution of articles and key journals. The use of the Scopus database in the study marks a difference.[13] In our study, the WoS database was used.

Another bibliometric study in the literature focused on "individuals experiencing homelessness", covering the years 2003-2016. After a systematic review process from 5 databases, a total of 50 published articles were selected. Despite the rarity of experimental studies and typically small sample sizes, the studies analyzing the impact of information and communication technologies on health were found to be beneficial.[14] In our study, articles from the years 1993-2024 were analyzed, providing a broader sample group. Additionally, only articles were included in both studies.

Another study using the WoS database related to healthy living indicated a growth rate of 26% since 2000.[15] The analysis results show that the number of publications on exercise applications for TMD has steadily increased over the years, with an annual growth rate of 2.65%. This increase indicates that exercise applications for TMD are increasingly valued by the scientific community and selected as a research topic. Bibliometric analysis helps us understand the reasons behind this increase and the dynamics driving it.

The most prolific journals, including the Journal of Oral Rehabilitation and CRANIO: The Journal of Craniomandibular&Sleep Practice, are instrumental in disseminating critical findings. Their frequent publication of TMD-related articles signifies their importance as primary outlets for researchers to share their work and influence clinical practices globally. These journals serve as key platforms for disseminating research findings in this field. This indicates that the journal has a particular interest in studies on TMD dysfunction and rehabilitation and serves as an essential publication platform for such studies. Additionally, the analysis of authorship identifies Fialka-Moser and Nicolakis as leading contributors, each with 5 articles, followed closely by Erdoğmuş and Kopf, each with 4 articles. These authors' prolific contributions have significantly shaped the research landscape, suggesting that their work is pivotal in advancing our understanding and treatment of TMD through exercise methods.

Institutional contributions are led by Vienna University, Ravi Nair Physiotherapy College, Granada University, and Hacettepe University. These institutions' significant output in TMD research underscores their roles as key centers for advancing knowledge and treatment strategies in this field.

Keyword analysis reveals that "exercise", "dysfunction", "management", "disorders", and "pain" are central themes in the literature. The frequent occurrence of these keywords indicates that research is particularly focused on the practical aspects of managing TMD through therapeutic exercises, highlighting the clinical relevance of these studies. Bibliometric analyses provide researchers and clinicians with the ability to track the most important studies and trends in the field. They also help identify which topics need more research and where knowledge gaps exist. This can guide future research and help plan scientific studies more effectively.[16]

Geographically, the USA, Brazil, India, Italy, and Türkiye are leading contributors to the TMD exercise methods literature. The diversity in research origins highlights a global interest and underscores the universal relevance of TMD and its treatment. The substantial contributions from these countries suggest robust research environments and dedicated efforts towards understanding and treating TMD through exercise.

Among the most cited articles, Medlicott and Harris, Hlawitschka, et al. and Widmark et al. have had a significant impact on the field, reflecting pivotal research developments and influential findings that have shaped current understanding and approaches to TMD treatment.[17-19]

In our study, the Bibliometrix application was used for bibliometric analysis. Bibliometrix is a tool developed in the R language that can perform statistical calculations according to a logical workflow and also create graphics. R is an object-oriented and functional programming language with the advantage of being highly extensible. Automating analyses and creating new functions with R is relatively easy for

the user. Additionally, Bibliometrix is open-source and flexible, allowing integration with other statistical R packages. These features make it a valuable tool for scientific research. It includes all fundamental bibliometric analysis methods, which enhances its widespread use, particularly in science mapping.[20-22] The presence of other studies in the literature that have used this tool directed us to choose it for our analysis.[23]

This research is limited to articles and keywords published in the WoS database before July 14, 2024.

CONCLUSION

Future studies should examine the effectiveness of exercise methods in the treatment of TMD in more detail and evaluate their applicability to different patient groups. Such studies will contribute to the development of more effective and personalized treatment protocols for TMD. Additionally, increasing international collaborations and expanding scientific networks in this field will enhance the quality and impact of research on TMD and exercise therapies. This will promote greater information sharing on a global scale and accelerate scientific progress in this area.

In conclusion, exercise methods for the treatment of TMD hold a significant place in the scientific literature, and research in this field continues to grow. Future research should examine the effectiveness and applicability of these treatment methods in greater detail, allowing for the development of more effective and reliable approaches for TMD treatment. Strengthening scientific collaborations and networks will significantly support the accumulation of knowledge and scientific development in this field.

Source of Finance

During this study, no financial or spiritual support was received neither from any pharmaceutical company that has a direct connection with the research subject, nor from a company that provides or produces medical instruments and materials which may negatively affect the evaluation process of this study.

Conflict of Interest

No conflicts of interest between the authors and / or family members of the scientific and medical committee members or members of the potential conflicts of interest, counseling, expertise, working conditions, share holding and similar situations in any firm.

Authorship Contributions

All authors contributed equally while this study preparing.

REFERENCES

1. Zlatanovska K, Longurova N, Dimova C, Zarkova-Atanasova J, Proseva L. Classificatıon of temporomandibular disorders. KNOWLEDGE-International J. 2021;49(4):693-8. [Link]
2. Wadhokar OC, Patil DS. Current trends in the management of temporomandibular joint dysfunction: a review. Cureus. 2022;14(9):e29314. [Crossref] [PubMed] [PMC]
3. Zhang L, Xu L, Wu D, Yu C, Fan S, Cai B. Effectiveness of exercise therapy versus occlusal splint therapy for the treatment of painful temporomandibular disorders: a systematic review and meta-analysis. Ann Palliat Med. 2021;10(6):6122-32. [Crossref] [PubMed]
4. Yamaguchi Y, Sakuma S, Ogi N, Taguchi N, Kimoto S. Short-term efficacy of exercise therapy for temporomandibular disorders: a case control study. J Phys Ther Sci. 2023;35(2):139-45. [Crossref] [PubMed] [PMC]
5. Merigó JM, Yang JB. A bibliometric analysis of operations research and management science. Omega. 2017;73:37-48. [Link]
6. Canik S, Güneren Özdemir E. Sağlık turizmini konu alan lisansüstü tezlerin bibliyometrik değerlendirmesi (1988-2017) [Bibliometric analysis of graduate thesis on health tourism (1988-2017)]. Anatolia Tur Araştırmaları Derg. 2019;30(2):125-34. [Crossref]
7. Temizkan P, Çiçek D, Özdemir C. Sağlık turizmi konusunda yayınlanan makalelerin bibliyometrik profili [Bibliometric profile of articles published on health tourism]. Int J Hum Sci. 2015;12(2):394. [Link]
8. Blažun Vošner H, Bobek S, Sternad Zabukovšek S, Kokol P. Openness and information technology: a bibliometric analysis of literature production. Kybernetes. 2017;46(5):750-66. [Crossref]
9. Yunting F, Zhu Q, Lai K-H. Corporate social responsibility for supply chain management: a literature review and bibliometric analysis. J Clean Prod. 2017;158(43):296-307. [Crossref]
10. Donthu N, Kumar S, Mukherjee D, Pandey N, Lim WM. How to conduct a bibliometric analysis: an overview and guidelines. J Bus Res. 2021;133:285-96. [Link]
11. Nasir A, Shaukat K, Hameed IA, Luo S, Alam TM, Iqbal F. A bibliometric analysis of corona pandemic in social sciences: a review of influential aspects and conceptual structure. IEEE Access. 2020;8:133377-402. [Crossref] [PubMed] [PMC]
12. Bayrak NG, Özkan E. Bibliometric analysis of studies on child abuse and negligence. Gümüşhane Üniversitesi Sağlık Bilim Derg. 2024;13(2):554-60. [Crossref]
13. Sikandar H, Vaicondam Y, Parveen S, Khan N, Qureshi MI. Bibliometric analysis of telemedicine and e-health literature. Int J online Biomed Eng. 2021;17(12):52-69. [Link]
14. Calvo F, Carbonell X, Johnsen S. Information and communication technologies, e-Health and homelessness: a bibliometric review. Cogent Psychol. 2019;6(1):1631583. [Link]

15. Müller AM, Maher CA, Vandelanotte C, Hingle M, Middelweerd A, Lopez ML, et al. Physical activity, sedentary behavior, and diet-related ehealth and mhealth research: bibliometric analysis. J Med Internet Res. 2018;20(4):e122. [Crossref] [PubMed] [PMC]

16. Baysal E, Aktan GG. Bibliometric analysis of oral mucositis studies in the nursing field: a descriptive study. Gümüşhane Üniversitesi Sağlık Bilim Derg. 2024;13(1):55-65. [Link]

17. Medlicott MS, Harris SR. A systematic review of the effectiveness of exercise, manual therapy, electrotherapy, relaxation training, and biofeedback in the management of temporomandibular disorder. Phys Ther. 2006;86(7):955-73. [Crossref] [PubMed]

18. Hlawitschka M, Loukota R, Eckelt U. Functional and radiological results of open and closed treatment of intracapsular (diacapitular) condylar fractures of the mandible. Int J Oral Maxillofac Surg. 2005;34(6):597-604. [Crossref] [PubMed]

19. Widmark G, Bågenholm T, Kahnberg KE, Lindahl L. Open reduction of subcondylar fractures. A study of functional rehabilitation. Int J Oral Maxillofac Surg. 1996;25(2):107-11. [Crossref] [PubMed]

20. Aria M, Cuccurullo C. Bibliometrix : an R-tool for comprehensive science mapping analysis. J Informetr. 2017;11(4):959-75. [Link]

21. Bankson HL. Health literacy: an exploratory bibliometric analysis, 1997-2007. J Med Libr Assoc. 2009;97(2):148-50. [Crossref] [PubMed] [PMC]

22. Shapiro RM. Health Literacy: A Bibliometric And Citation Analysis [Master's thesis]. Kentuck: University of Kentucky; 2010. [Link]

23. Akyüz S. Sağlık okuryazarlığı araştırmalarının bibliyometrik analizi [Bibliometric analysis of researches on health literacy]. Genel Tıp Derg. 2021;31(4):402-16. [Link]